PiC

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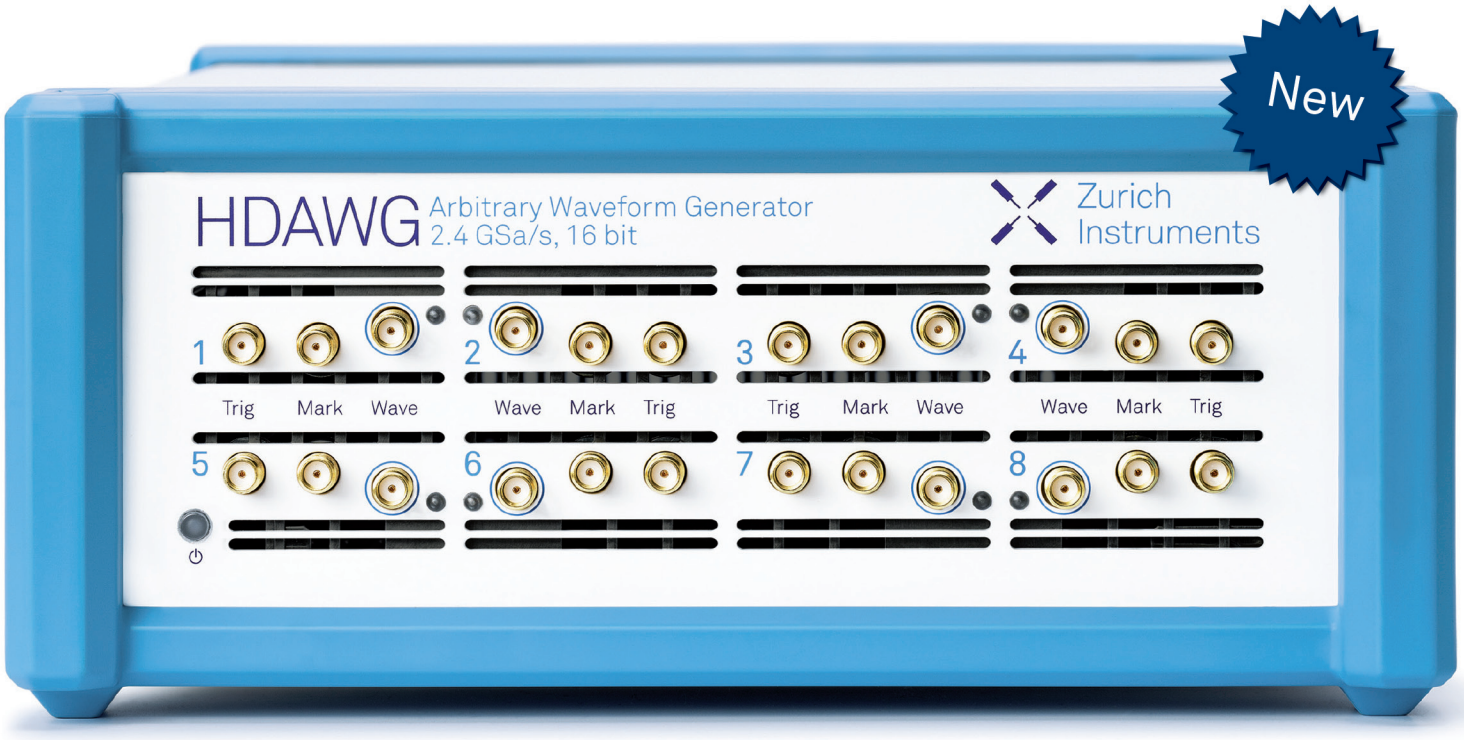

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"Supported through Tension" by Oswald Pan, Victoria Park Collegiate Institute, Toronto, ON. First Prize, High School Individual Category, 2017 CAP Art of Physics Competition. See https://www.cap.ca/programs/art-physics/past-winners/.

The Local Organizing Committee delivers a memorable experience for all Congress delegates, including our 2017 Medalists (2nd photo from left) and APS President Dr. Laura Greene (middle, photo on far right), attending the 2017 CAP Congress in Kingston, ON.

« Supported through Tension » par Oswald Pan, Victoria Park Collegiate Institute, Toronto, ON. Première place, catégorie élèves (individuel), Concours l'Art de la physique 2017. Voir https://www.cap.ca/fr/activites/lart-de-physique/past-winners/.

Le Comité organisateur local a fait du Congrès 2017 à Kingston, Ontario, une expérience mémorable pour tous les délégués, incluant nos Lauréats de 2017 (2e photo depuis la gauche) et la présidente de l'APS la Dr Laura Greene (milieu, la photo tout à droite).

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Canadian Association of Physicists (CAP)
Association canadienne des physiciens et physiciennes (ACP)

The Canadian Association of Physicists was founded in 1945 as a non-profit association representing the interests of Canadian physicists. The CAP is a broadly-based national network of physicists working in Canadian educational, industrial, and research settings. We are a strong and effective advocacy group for support of, and excellence in, physics research and education. We represent the voice of Canadian physicists to government, granting agencies, and many international scientific societies. We are an enthusiastic sponsor of events and activities promoting Canadian physics and physicists, including the CAP's annual congress and national physics journal. We are proud to offer and continually enhance our web site as a key resource for individuals pursuing careers in physics and physics education. Details of the many activities of the Association can be found at http://www.cap.ca. Membership application forms are also available in the membership section of that website.

L'Association canadienne des physiciens et physiciennes a été fondée en 1946 comme une association à but non-lucratif représentant les intérêts des physicien(ne)s canadien(ne)s. L'ACP est un vaste regroupement de physiciens oeuvrant dans les milieux canadiens de l'éducation, de l'industrie et de la recherche. Nous constituons un groupe de pression solide et efficace, ayant pour objectif le soutien de la recherche et de l'éducation en physique, et leur excellence. Nous sommes le porte-parole des physiciens canadiens face au gouvernement, aux organismes subventionnaires et à plusieurs sociétés scientifiques internationales. Nous nous faisons le promoteur enthousiaste d'événements et d'activités mettant à l'avant-scène la physique et les physiciens canadiens, en particulier le congrès annuel et la revue de l'Association. Nous sommes fiers d'offrir et de développer continuellement notre site Web pour en faire une ressource clé pour ceux qui poursuivent leur carrière en physique et dans l'enseignement de la physique. Vous pouvez trouver les renseignements concernant les nombreuses activités de l'ACP à http://www.cap.ca. Les formulaires d'adhésion sont aussi disponibles dans la rubrique «Adhésion» sur ce site.

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BEING A CAP MEMBER IN 2018

November 7th, 2017 was declared Membership Action Day by the CAP. This initiative followed an intense period of reassessment of the activities of the CAP and a significant investment of resources to improve communications with its members. During the last year, the CAP underwent major changes in its operations to improve the experience of its members and recruit new members: News Flashes, News Bulletins, a revamped web site, and searchable archives for *Physics in Canada* going back to the very first issue published in 1955 were introduced, all of which present the image of a more dynamic and visible organization which wants to strengthen the bond with its members and engage them in the advancement of physics in Canada. These new features connect us to the present and the past and work to position us for the future. The new website offers links and resources on careers, posters and videos promoting the study of physics to high school students, information for parents, university students and educators, and a link on actions that members can take to build a stronger physics community. These improvements make it timely to discuss the best strategies needed to keep CAP membership healthy.

The merits of membership are many. It is generally known that the CAP is the official association representing all physicists in Canada, that it organizes the annual CAP Congress (the only general physics conference in Canada and the place to meet colleagues from across the country), that it publishes *Physics in Canada*, the voice of the Canadian physics community, and that it organizes a number of activities for students (e.g., the CAP Lecture tour).

More significantly, the CAP is the only association fighting for the rights of all Canadian physicists and lobbying on their behalf. It has been generally recognized that the CAP's lobbying initiatives over the years have been very effective. Probably less well-known is that the CAP has successfully fought attempts by engineering associations in a number of provinces to modify the definition of the practice of engineers in a way that could limit the professional practice of physicists. This lead to the creation of the PPhys accreditation, with the aim of raising the profile of physicists in the workforce.

The CAP performs additional services for its members, such as establishing joint memberships or signing accords with other physics organizations. For instance, CAP members pay the same fees as APS members when registering for APS meetings.

For all these reasons, the CAP deserves our support. We have a vibrant and strong physics community, which should provide a strong base for growth in membership, especially at a time when physics-based research frequently makes the covers of popular magazines such as *Scientific American* and *La Recherche*.

However, the situation is not as straightforward as it may seem. The CAP is facing a physics community that is undergoing rapid change. As all disciplines of science are becoming more quantitative and predictive, the role of physics and physics-based tools increase in importance and the realm of applications of physics and the activities of physicists grow. While this raises the public profile of physics; it does, however, have another effect. It is taking students and faculty away from core physics and sometimes distances them from pure physics activities. Associations, such as the Canadian Organization of Medical Physicists, the Canadian Astronomical Society (CASCA) and the Biophysical Society of Canada (BPSCan), serve the needs of those physics researchers, whether in astronomy, astrophysics, biophysics, or medical physics. These associations compete for our members' loyalty.

In 2017, the soft matter community decided to organize a symposium at the CAP Congress which involved members from both the CAP and the BPSCan. This suggests that the way to a sustainable future will involve more partnerships and joint meetings, and maybe a rethinking of the CAP's annual Congress. It is counterproductive to try to impose a unified image of physics where we all share the same hierarchy of values in the programming of the congress. The membership structure will have to continue to adapt.

Tackling the increased diversity of physics head-on will increase the influence of the CAP. The CAP should strive to act as an umbrella organization, regrouping all physicists under its leadership. After all, the CAP performs roles that

not all of the more specialized associations do, such as lobbying, publishing a magazine, and engaging in outreach activities. The CAP is the only comprehensive voice for Canadian physicists. We are still far from the situation in the humanities, with multiple associations representing individual disciplines, but we could learn, as we look to the future, from their joint Congress, organized by the Federation of the Humanities and Social Sciences which assembles them each year in one location.

As a final word, I would like to quote from my 2006 editorial on "Being a witness for the CAP": "The arguments in support of membership in the CAP are many, but simply put, every experienced physicist would expect the CAP to exist, as one would expect the APS, the Australian Phys. Soc., the Austrian Phys. Soc., the Italian Physical Soc., or the German Phys. Soc., to name only a few, to exist. But, if it is to exist, it can only do so with the support of paying members. Every profession needs an association to represent its interests, and to act as a (locus for) the meeting of minds to guide the community. To be a full-fledged member of the community of Canadian physicists means being a CAP member. To many this is clear but, judging by the numbers, there are many more to whom this point is not obvious or is not appreciated."

Many physicists, even those who support the CAP, have a rather limited perception and appreciation of what it does for the community. As Richard MacKenzie wrote in his Outgoing President's report [2], it is only by serving on the executive that he really came to appreciate the breadth of the activities of the CAP. It is the responsibility of all active members to act as witnesses for the CAP and to help the organization reach its goal of 2020 members by 2020 (a growth of about 20% from its current level of 1,700 members). We should not remain closet CAP members but should believe in the organization enough to speak out on its behalf.

As we embark in 2018, let us reach out to our new and old colleagues, and help make the CAP a strong and lively organization.

Béla Joós
University of Ottawa
Physics in Canada Editor

Comments of readers on this Editorial are more than welcome.

REFERENCES

1. B. Joós, "Being a witness for the CAP" (Editorial), *Physics in Canada*, **62**(6), 334-335 (2006).
2. Richard MacKenzie, "Report of the Outgoing President of the CAP", *Physics in Canada*, **73**(3), 158-165 (2017).

ÊTRE MEMBRE DE L'ACP EN 2018

L'ACP a fait du 7 novembre 2017 sa Journée d'action pour l'adhésion. Cette initiative fait suite à une période intense de réévaluation des activités de l'ACP et à une importante mise de ressources pour améliorer les communications avec ses membres. L'année dernière, l'ACP a revu son fonctionnement en profondeur afin d'améliorer l'expérience de ses membres et d'en recruter de nouveaux : bulletins et messages d'information, site Web renouvelé et archives de *La Physique au Canada* interrogeables depuis le tout premier numéro publié en 1955 ont vu le jour. Tout cela reflète l'image d'un organisme plus dynamique et visible qui veut renforcer ses liens avec ses membres et les engager dans l'avancement de la physique au Canada. Ces traits nouveaux nous relient au présent et au passé et renforcent notre position pour l'avenir. Le nouveau site Web contient des liens et des ressources sur les carrières, des affiches et des vidéos vantant l'étude de la physique auprès des étudiants du secondaire, de l'information pour les parents, les étudiants et professeurs d'université, et un lien sur les gestes que peuvent poser les membres pour renforcer la collectivité de la physique. Par suite de ces améliorations, le moment est bien choisi pour discuter des stratégies optimales permettant de maintenir l'effectif de l'ACP à un niveau viable.

Les avantages de l'adhésion sont nombreux. Il est généralement connu que l'ACP est l'association qui représente officiellement tous les physiciens au Canada, qu'elle organise son congrès annuel (la seule conférence générale de physique au Canada et l'endroit où rencontrer des collègues de tout le pays), qu'elle publie *La Physique au Canada*, porte-parole de la collectivité canadienne de la physique, et qu'elle organise diverses activités pour les étudiants (p. ex. la Tournée de conférenciers de l'ACP).

Plus important encore, l'ACP est la seule association qui défend les droits de tous les physiciens canadiens et exerce des pressions en leur nom. Il est généralement reconnu que les initiatives de lobbying de l'ACP au fil des ans ont été très efficaces. Il est peut-être moins connu que l'ACP s'est opposée avec succès aux tentatives des associations d'ingénieurs de diverses provinces de modifier la définition de l'exercice professionnel des ingénieurs avec le but de limiter celle des physiciens. Cela a amené la création de l'accréditation Phys, afin de relever le profil des physiciens en milieu de travail.

L'ACP rend d'autres services à ses membres, comme celui d'établir des adhésions conjointes ou de signer des accords avec d'autres organismes de physique. Par exemple, les membres de l'ACP versent les mêmes droits que ceux de l'APS pour s'inscrire aux conférences de celle-ci.

Pour toutes ces raisons, l'ACP mérite notre appui. Nous avons une collectivité de la physique qui est dynamique et forte et devrait être une assise solide pour accroître son effectif, en particulier au moment où la recherche fondée sur la physique fait souvent la une de revues populaires telles que *Scientific American* et *La Recherche*.

La situation n'est toutefois pas aussi simple qu'il y paraît. L'ACP fait face à une collectivité de la physique aux prises avec des changements rapides. Comme toutes les disciplines scientifiques deviennent plus quantitatives et prédictives, le rôle de la physique et des outils fondés sur cette discipline gagne en importance et le champ de ses applications et des activités des physiciens va grandissant. Cela relève le profil public de la physique, mais il en découle cependant une autre conséquence. Cela éloigne les étudiants et les professeurs de la physique de base et parfois aussi des activités de physique pure. Des associations, telles l'Organisation canadienne des physiciens médicaux (COMP), la Société canadienne d'astronomie (CASCA), et la Société de biophysique du Canada (BPSCan) visent à répondre aux besoins des chercheurs en physique, que ce soit en astronomie, astrophysique, biophysique, et physique médicale. Ces associations rivalisent pour attirer la loyauté de nos membres.

En 2017, la collectivité de la matière molle a décidé, au congrès annuel de l'ACP, de tenir un symposium regroupant les membres tant de l'ACP que de BPSCan. Cela montre que, pour que l'avenir soit viable, il faudra avoir davantage de partenariats et de réunions conjointes, et peut-être repenser le congrès annuel de l'ACP. Il est contreproductif de tenter d'imposer une image unifiée de la physique selon laquelle tous ont la même hiérarchie de valeurs dans la programmation du congrès. La structure de l'effectif devra continuer de s'adapter.

Si l'on fait face directement à la diversité accrue de la physique, on élargira l'influence de l'ACP. Celle-ci devrait s'efforcer d'agir en organisme-cadre, regroupant sous sa coupe tous les physiciens. Après tout, l'ACP joue des rôles comme le lobbying, la publication d'une revue et l'exercice d'activités de sensibilisation, qui échappent aux associations plus spécialisées. Elle est le seul porte-parole de l'ensemble des physiciens canadiens. Nous sommes encore loin de la situation, dans le domaine des sciences humaines, où de multiples associations représentent les diverses disciplines, mais nous pouvons, en contemplant l'avenir, tirer des leçons des Congrès organisés par la Fédération des sciences humaines qui les rassemblent chaque année en un lieu..

Enfin, j'aimerais reprendre le message transmis dans mon éditorial « Être des témoins pour l'ACP », en 2006 : « Les arguments favorisant l'adhésion à l'ACP sont nombreux, mais, en termes simples, tout physicien d'expérience s'attendrait à l'existence de l'ACP, comme à celle de l'APS et des sociétés de physique d'Australie, d'Autriche, d'Italie ou d'Allemagne, pour n'en nommer que quelques-unes. Mais si l'ACP doit exister, cela n'est possible qu'avec l'appui des membres cotisants. Chaque profession a besoin d'une association pour défendre ses intérêts et agir comme point de ralliement pour guider sa collectivité. Pour être membre à part entière de la collectivité des physiciens canadiens, il faut faire partie de l'ACP. Cela est manifeste dans l'esprit de beaucoup, mais si l'on s'en fie aux chiffres, il y en a bien d'autres pour qui cela n'est ni évident ni compris. »

Bon nombre de physiciens, même ceux qui appuient l'ACP, ont une perception et une compréhension assez limitées de ce qu'elle fait pour la collectivité. Comme l'a écrit Richard MacKenzie dans son rapport du président sortant [2], ce n'est qu'en servant la direction qu'il en est venu à saisir l'ampleur des activités de l'ACP. Il appartient à tous les membres actifs de se faire les témoins de l'ACP et de l'aider à atteindre son objectif de 2020 membres d'ici 2020 (hausse d'environ 20 % de son effectif actuel de 1 700 membres). Il ne faut pas demeurer des membres inavoués de l'ACP mais bien croire suffisamment en elle pour parler en son nom.

En conséquence, commençons la nouvelle année 2018 en communiquant avec nos collègues, nouveaux et anciens, et aidons l'ACP à devenir un organisme fort et dynamique.

Béla Joós
Université d'Ottawa
Rédacteur-en-chef, *La Physique au Canada*

Les commentaires des lecteurs sur cet éditorial sont toujours les bienvenus.

NOTE: Le genre masculin n'a été utilisé que pour alléger le texte.

RÉFÉRENCES

1. B. Joós, « Être des témoins pour l'ACP », (éditorial) *La Physique au Canada*, **62**(6), 334-335 (2006).
2. Richard MacKenzie, « Rapport du président sortant de l'ACP », *La Physique au Canada,* **73**(3), 158-165 (2017).

2017 Student Competitions / *Compétitions étudiantes 2017*

(SEE EXTENDED ABSTRACTS OF THE WINNERS ON PAGES 176-189 PLUS PHOTOS ON PAGE 175 / *VOIR LES RÉSUMÉS DES GAGNANTS AUX PAGES 176-189 ET PHOTOGRAPHIES A LA PAGE 175*)

The Canadian Association of Physicists has established these awards to recognize student members giving the best oral and poster research presentations at the annual CAP Congress. Up to three awards in each category, each consisting of a certificate of recognition and a cash prize, are made each year. in addition, a number of CAP Divisions offer prizes for the best student presentations at the divisional level. Eligibility, selection procedure, and selection criteria for the competitions are available through the Congress website each year.

L'Association canadienne des physiciens et physiciennes a créé ces prix afin de récompenser les membres étudiants auteurs des meilleures communications au congrès annuel. Elle décerne tous les ans un maximum de trois prix dans chaque catégorie, chacun consistant d'un certificat de mérite et d'une somme. De plus, plusieurs divisions offrent des prix pour leurs meilleures présentations étudiantes. Admissibilité, modalités et critères de sélection pour les prix sont sur le site web de l'ACP.

CAP Division Prizes / *Prix des divisions de l'ACP*

Division prizes included a cash prize of $200 for first, $100 for second, and $50 for third. /
Les prix des divisions incluent une somme de 200 $ (1er), 100 $ (2e) et 50 $ (3e).

ATMOSPHERIC AND SPACE PHYSICS	
Placement	**Name / Affiliation**
Oral-First	Lindsay Goodwin, University of Saskatchewan

ATOMIC, MOLECULAR AND OPTICAL PHYSICS, CANADA	
Placement	**Name / Affiliation**
Poster-First	Chris Gustin, Queen's University
Poster-Second	Sai Sreesh Venuturumilli, University of Waterloo
Oral-First	Chris Pugh, University of Waterloo
Oral-Second	Nafiseh Sang-Nourpour, University of Calgary

CONDENSED MATTER AND MATERIALS PHYSICS	
Placement	**Name / Affiliation**
Poster-First	Sanyasi Rao Bobbara, Queen's University
Oral-First	Jean-Christophe Ono-dit-Biot, McMaster University
Oral-Second	Carolyn Cadogan, University of Western Ontario
Oral-Third	Sarah Dawson, McMaster University

NUCLEAR PHYSICS	
Placement	**Name / Affiliation**
Oral-First	Justine Joyce Munich, Simon Fraser University
Oral-Second	Anish Verma, Simon Fraser University

PARTICLE PHYSICS	
Placement	**Name / Affiliation**
Poster-First	Andrew Erlandson, Canadian Nuclear Labs
Poster-Second	Carl Rethmeier, Carleton University
Oral-First	Pawel Mekarski, University of Alberta
Oral-Second	Daniel Durnford, Queen's University
Oral-Third	Gabriel Magill, McMaster University
Oral-HM	Joseph McLaughlin, Queen's University
Oral-HM	Ingrida Semenec, Laurentian University
Oral-HM	Connor Stone, Queen's University

PHYSICS EDUCATION, SURFACE SCIENCES, INSTRUMENTATION & MEASUREMENT	
Placement	**Name / Affiliation**
Oral-First	William Lemaire, Université de Sherbrooke
Oral-Second	Matt Bumstead, McMaster University

PHYSICS IN MEDICINE AND BIOLOGY	
Placement	**Name / Affiliation**
Poster-First	Hourieh Exir, University of Ottawa
Oral-First	Adree Khondker, McMaster University
Oral-Second	Richard Alsop, McMaster University
Oral-Third	Kenneth Blahut, Ryerson University

THEORETICAL PHYSICS	
Placement	**Name / Affiliation**
Oral-First	Robie Hennigar, University of Waterloo
Oral-Second	Keith Ng, University of Waterloo

WOMEN IN PHYSICS	
PLACEMENT	**NAME / AFFILIATION**
Poster	Hourieh Exir, University of Ottawa

CAP AWARDS - POSTER

Poster prizes included a certificate of recognition and a cash award of $400, $200, and $100 respectively for the top three placements sponsored by Canadian Science Publishers.

2017 CAP Poster Award Recipients and Honourable Mentions (one absent from photo).

PLACEMENT	NAME / AFFILIATION
First	Carl Rethmeier, Carleton University
Second (tie)	Jack Davis, University of Waterloo
Second (tie)	Hourieh Exir, University of Ottawa
Finalist - HM	Sanyasi Rao Bobbara, Queen's University
Finalist - HM	Sai Sreesh Venuturumilli, University of Waterloo

CAP AWARDS - ORAL PRESENTATIONS

Oral prizes included a certificate of recognition, and a cash award of $400, $200, and $100 respectively for the top three placements sponsored by Wiley.

2017 CAP Oral Award Recipients and Honourable Mentions (three absent from photo).

PLACEMENT	NAME / AFFILIATION
First	Jean-Christophe Ono-dit-Biot, McMaster University
Second (tie)	Adree Khondker, McMaster University
Second (tie)	Justine Joyce Munich, Simon Fraser University
Finalist - HM	Lindsay Goodwin, University of Saskatchewan
Finalist - HM	Robie Hennigar, University of Waterloo
Finalist - HM	Chris Pugh, University of Waterloo
Finalist - HM	Pawel Mekarski, University of Alberta

Thanks to the CAP competition sponsors / *Merci au commanditaire de la compétition de l'ACP:*

Canadian Science Publishing

and

Wiley

and to the CAP's Vice-President Elect at that time, Dr. Bruce Gaulin of McMaster University, and all of the judges for their extraordinary efforts in organizing this event. Our thanks are also extended to all competitors.

The winners of the 2017 CAP Best Student Presentation Competition at the CAP Annual Congress, 2017 May 29 - June 2, in Kingston are listed on pages 174-175. The extended abstracts of those winners of the CAP prizes who submitted them for publication are reproduced below. Ed.

CAFFEINE IN DRUG COCKTAILS: THE FORMATION OF "WATER POCKETS" IN MEMBRANES

BY ADREE KHONDKER[1], ALEXANDER K. DHALIWAL, RICHARD J. ALSOP, JENNIFER TANG, MATILDA BACKHOLM, AN-CHANG SHI, AND MAIKEL C. RHEINSTÄDTER

Adree Khondker[a] <khondkea@mcmaster.ca>, Alexander K. Dhaliwal,[a] Richard J. Alsop,[a] Jennifer Tang,[a] Matilda Backholm,[b] An-Chang Shi,[a] and Maikel C. Rheinstädter[a] <rheinstadter@mcmaster.ca>

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[b]Department of Applied Physics, Aalto University, Helsinki, Finland

Caffeine is a small, hygroscopic molecule that we commonly associate with coffee. Although caffeine is the world's most prevalent psychostimulant [1], it is also one of the world's most common drug adjuvants – according to the DrugBank [2] it is included in more than 500 pharmaceutical preparations. In our research, we looked into the biophysical processes which govern the non-specific interactions between caffeine and primary drugs in pharmaceutical cocktails. We found that caffeine partitions in the hydrophilic-hydrophobic interface of the membranes and leads to changes in the membrane structure, which can substantiate the interaction between drugs and the membrane milieu [3].

Because of their simplicity, synthetic membranes are excellent model systems, both experimentally and computationally, to identify fundamental biophysical processes. In order to mimic a basic eukaryotic membrane, we prepared unsaturated/saturated zwitterionic lipid membranes of 1-palmitoyl-2-oleoyl-sn-glycerol-3-phosphocholine (POPC) with 3 mol% caffeine, a typical blood concentration of caffeine after drinking two cups of coffee. Multi-lamellar stacks of membranes were prepared on silicon wafers. The samples were then studied with X-ray diffraction and Molecular Dynamics (MD) simulations to probe the structural and kinetic biophysical processes. Experiments were conducted in-house using our high-resolution and high-intensity Biological Large Angle Diffraction Experiment (BLADE). MD simulations were conducted in-house using GROMACS on MacSim, a high performance GPU powered workstation.

SUMMARY

This article reports on the biophysical consequences of induced hygroscopic "water pockets" in cell membranes by the small molecule caffeine to understand membrane-mediated drug interactions.

As coffee is in particular known to have an impact on fluid balance in the body, the membranes were scanned at different relative humidities (RH) of 97%, 93%, and 85% RH equivalent to different osmotic pressures. All membranes were first transferred into a glove box and kept at 10% RH for 24–48 h to completely dehydrate the membranes prior to scanning. During the experiments, membranes were kept in a humidity chamber and the humidity was controlled through different saturated salt solutions.

In experiment and simulations, we observed that caffeine spontaneously partitioned in the membranes, between the lipid head and tail groups, as shown in Fig. 1. The

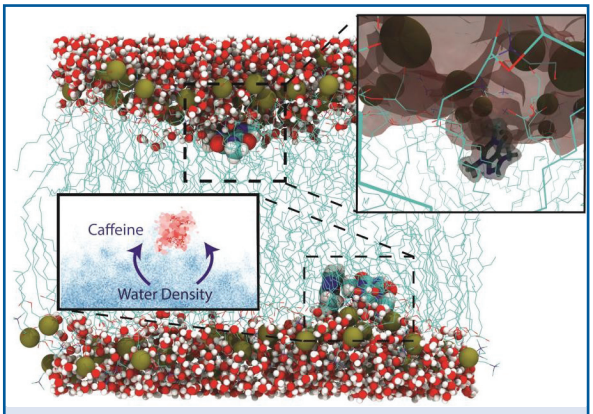

Fig. 1 Simulation snapshot of membrane system with embedded caffeine. Caffeine molecules spontaneously partition into membranes and locate in the interface between lipid head groups and lipid tails. Water molecules are then drawn to this interface. The subplot shows a zoomed-in image with the darker density representing the water molecules protruding into the membrane around the caffeine.

1. Adree Khondker tied for 2nd place in the CAP Best Student Oral Presentation competition at the 2017 CAP Congress at Queen's University in Kingston, ON.

amphiphilic caffeine molecule orients its relatively polar group toward the head groups, and the relatively nonpolar segment toward the lipid tails. However, it typically takes several hours in the experiments for the systems to reach equilibrium. In time-resolved diffraction experiments we found evidence that caffeine slowed down hydration of the membranes, i.e., the uptake of hydration water molecules, but at the same time led to an increased amount of hydration water molecules in the hydrophobic membrane core.

We used time-resolved X-ray diffraction to measure the evolution of the membrane width. Hydration in biology typically results in an increase in the number of hydration water molecules around a biological system. Interestingly, when the lamellar spacing, d_z, was decoupled into the thickness of the hydration water layer and the actual membrane thickness, we observed that caffeine led to an increase of membrane thickness, instead of increasing the hydration water layer. By fitting the increase in thickness (d_z) to an exponential curve, the corresponding time constants, τ, were determined (see Fig. 2a). By measuring τ at different relative humidities, we propose a modified Arrhenius equation $\left(\tau = \tau_0 \exp\left(\frac{\Delta E}{k_B T}\right)\right)$ to determine the corresponding hydration energy barrier, ΔE, for a water molecule to enter the interfacial layer of the membrane by using:

$$\Delta E = \alpha k_B T \ln\left(\frac{p}{p_0}\right).$$

A relative humidity $RH = p/p_0$ creates an osmotic pressure $\Pi_{osm} = (k_B T/v_w)\ln(p_0/p)$ (where v_w is the partial molar volume of a water molecule). The energy barrier to diffuse into the bilayer, ΔE, was assumed to be proportional to the change in chemical potential of the water molecules. The slope α to the logarithmic plots is fit in Fig. 2b). The two straight lines for POPC with and without caffeine are parallel to each other, suggesting that the effect of the relative humidity on the water diffusion is independent of the presence of caffeine. In summary, caffeine alters the membrane thickness by attracting greater amounts of water towards the caffeine, functionally dehydrating the rest of the bilayer.

To consolidate the experimental findings and investigate the mechanistic upbringing of this increase in membrane thickness, we used unified-atom molecular dynamics (MD) simulations. Typical simulation parameters and equilibrations were used [4], and production runs were performed for 200 ns. Measurements of membrane width, area-per-lipid, and caffeine partitioning in simulation agreed well with experiment such that the results can be directly compared. MD simulations can then provide atomistic resolution and allow for extrapolation of experimentally inaccessible parameters

As shown in the inset to Fig. 1, caffeine molecules spontaneously partition and interact with the lipid head groups and attract water molecules. The presence of caffeine in the head-tail interface of the membranes drew a significant amount of water molecules into the lipid tails, creating "water pockets". In doing so, the interaction began to affect the lipid tail structure, specifically perturbing the membrane's fluidity — a measure of the disorder of lipid tails. By measuring the proportion of kinks (i.e., gauche dihedrals) in the 16/18-carbon tails, we observed that the adsorption of caffeine increases the number of defects locally near the molecule while decreasing the number of defects away

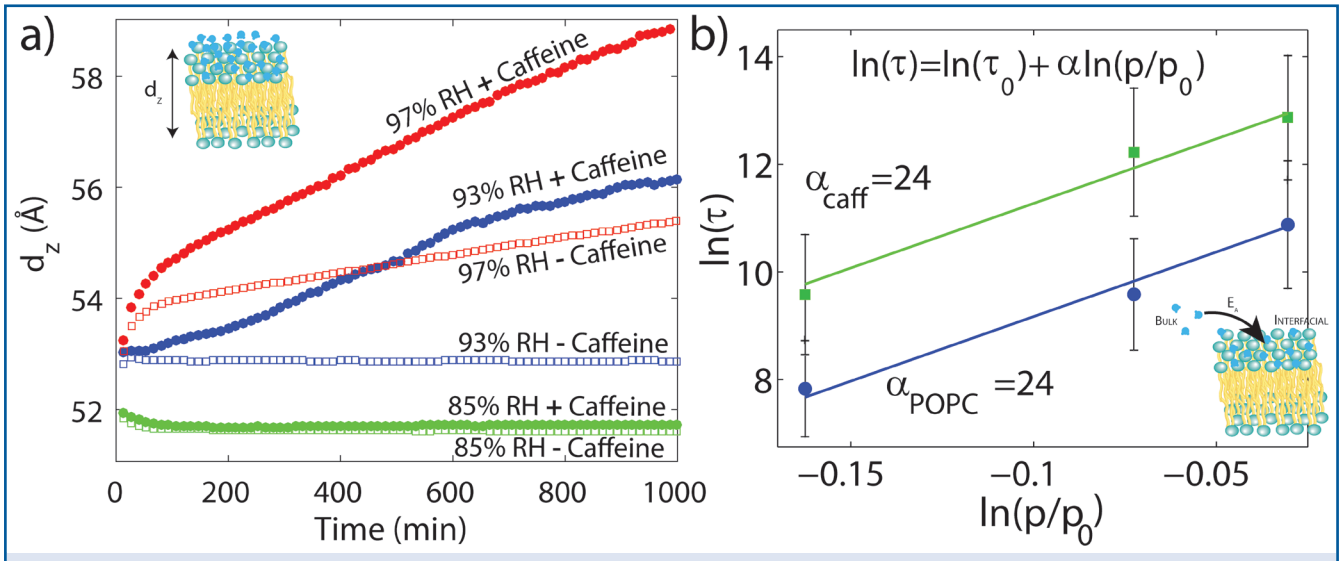

Fig. 2 The energy landscape for adding hydration water molecules to the membranes can be probed by measuring membrane swelling (a) as a function of relative humidity. The slope of this modified Arrhenius behaviour, a, was the same in membranes with and without caffeine (b). The derivation of this relationship is given in Khondker *et al.* 2017 [3].

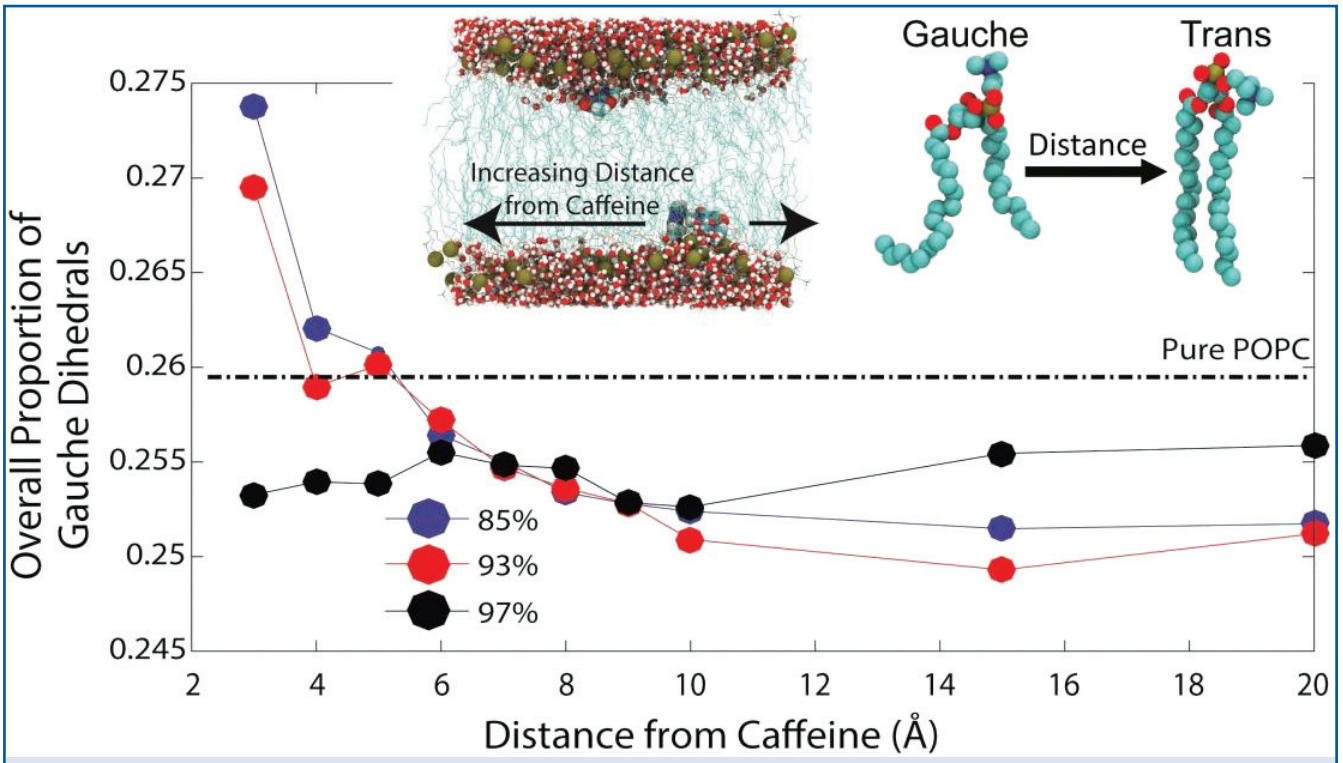

Fig. 3 Proportion of gauche dihedrals on lipid tail carbon atoms as a function of lipid distance from caffeine molecules at different hydration levels. The average gauche defect density of a pure POPC bilayer is plotted as dashed-dotted line for comparison. While the number of gauche defects is significantly increased near the caffeine molecules, the overall or averaged number of gauche defects is decreased as compared to pure POPC farther from the caffeine, indicative of a dehydration of the membranes.

from the molecule, as shown in Fig. 3. This led to the dehydration of membrane lipids farther from each caffeine molecule, which causes an overall decrease in membrane fluidity. A decrease in membrane fluidity — an increase in lipid tail order — is known to result in an increased membrane thickness [3], in agreement with the experiment.

In summary, we have gained an understanding of the effects of the hygroscopic molecule caffeine on lipid membranes by combining X-ray diffraction and MD computer simulations. We find that the formation of "water pockets", as a result of caffeine partitioning into the membranes, increases local membrane fluidity, while functionally dehydrating the rest of the membrane bilayer. This molecular dehydration precedes the increased intermembrane thickness and reduced bilayer swelling. Changes in membrane thickness and dynamic state of the lipid molecules lead in particular to changes of important membrane properties, such as diffusion and permeability. Such biophysical interactions could play a significant role in the rate of metabolism of analgesics [5]; therefore the presence of caffeine may make analgesics available in the body for longer periods of time than if administered independently. Our work thus provides a novel locus of interaction between bioactive molecules facilitated by a membrane surface, such as those found in the human body. To our knowledge, these are also the first experimental findings towards membrane surface bioenergetics with X-ray diffraction.

ACKNOWLEDGEMENTS

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MICROWAVE SPECTROSCOPY OF ANTIHYDROGEN AS A TEST OF CPT SYMMETRY

BY JUSTINE J. MUNICH[1]

SUMMARY

Antihydrogen comparisons with hydrogen are promising candidates for charge parity time (CPT) symmetry tests. This paper explores how microwave spectroscopy can help test CPT invariance.

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This is an exciting time to be in antihydrogen physics. Recent advances in antihydrogen production and trapping have allowed the Antihydrogen Laser Physics Apparatus (ALPHA) Collaboration to produce and trap antihydrogen atoms in record numbers [1]. We are trapping tens of antiatoms per antiproton bunch on average, compared to 1 antiatom every ten bunches in 2010 [2]. The abundance of antiatoms in our trap enables statistical significance for spectroscopic measurements in record times. Antihydrogen is a field worth following for the next few years!

This paper will focus on microwave spectroscopy of ground state antiatoms in a magnetic trap, which probes the interactions of the antiparticle spins with each other and with the external magnetic field. In 2012 we reported on an experiment in which transitions were induced between hyperfine levels of ground state antihydrogen atoms held in a magnetic trap [3]; here I will describe potential avenues for refinement. This area is rich in opportunities for measurements that can be compared with hydrogen to test charge parity time (CPT) symmetry. With hydrogen being one of the simplest and best understood systems in physics, studying antihydrogen provides a rich landscape of possibilities [4]. CPT invariance is a basic tenet of quantum field theories and the Standard Model, and forms a key part of the current understanding of our universe.

The hydrogen atom is one of the few real-world quantum mechanical systems that has a Hamiltonian that can be solved analytically with few approximations. Any graduate student and many undergraduates will find that with paper and pencil, and perhaps a quick refresher on Hamiltonian mechanics, the hydrogen Hamiltonian in an external magnetic field is easily solved. Here, I will show the solutions for antihydrogen, which can be solved using the same techniques while using experimentally derived values for antimatter instead of those of matter. Four eigenstates emerge. Table 1 shows the results of these calculations. Two of these states are product states: $|b\rangle$ and $|d\rangle$. There are two more entangled states of the two spins, $|a\rangle$ and $|c\rangle$, but in high fields the coefficients shift to one of the simple products of single particle states. In our trap, we are well within the high field regime, so we will consider all the eigenstates as products of single particle states. Once we know the eigenstates, we can solve for the energies of each as well.

Knowing this, we can plot the Breit-Rabi diagram for ground state antihydrogen, shown in Fig. 1. This calculation assumes CPT invariance of course, so this is what we will be comparing to in order to search for deviations. Notice that I've drawn in some specific transitions in the diagram; these transitions correspond to a spin flip for the positron. Positron spin resonance (PSR) transitions are analogous to electron spin resonance (ESR) transitions. While it is clear that the frequencies of these transitions are dependent on the external magnetic field, the difference between them is not. In fact,

$$\Delta E = (E_d - E_a) - (E_c - E_b) = a, \qquad (1)$$

which corresponds to the well known 21 cm spectral line for hydrogen. And if CPT invariance holds, then this splitting should have the same value for antihydrogen. This is what we're after in our tests.

At the European Organisation for Nuclear Research (CERN), we collect antiprotons in bunches of about ninety thousand every two minutes. We use a radioactive sodium source to produce positrons. Through a series of manoeuvres in a stack of electrodes we can collect, cool, and mix the antiprotons with about 1.6 million positrons. They will bind to create antihydrogen, and a fraction of the antiatoms we produce can be trapped in a magnetic potential well. The magnetic minimum is situated in the centre of our apparatus, and is formed through the use of an octupole and various solenoids.

1. Justine Munich tied for 2nd place in the CAP Best Student Oral Presentation competition at the 2017 CAP Congress at Queen's University in Kingston, ON.

TABLE 1

NOTATION: THE MAGNETIC MOMENTS OF THE POSITRON AND ANTIPROTON ARE μ_e+ AND $\mu_{\bar{p}}$, RESPECTIVELY. THE ZERO FIELD SPLITTING IS $\frac{a}{h} \approx 1420$ MHz AND IS KNOWN TO VERY HIGH PRECISION FOR HYDROGEN. THE FIRST ARROW INDICATES THE POSITRON SPIN ($\uparrow$ AND $\downarrow$). THE SECOND (BOLDED) ARROW DENOTES THE ANTIPROTON SPIN ($\Uparrow$ AND $\Downarrow$).

State	Basis States in Zero Field	Basis States in High Field	Energy
$\|a\rangle$	$\frac{\|\downarrow\Uparrow\rangle - \|\uparrow\Downarrow\rangle}{\sqrt{2}}$	$\|\uparrow\Downarrow\rangle$	$E_a = -\frac{a}{4}\left[1+2\sqrt{1+\frac{4\left(\mu_e + -\mu_{\bar{p}}\right)^2 B^2}{a^2}}\right]$
$\|b\rangle$	$\|\uparrow\Uparrow\rangle$	$\|\uparrow\Uparrow\rangle$	$E_b = \frac{a}{4} + \left(\mu_{e+} + \mu_{\bar{p}}\right)B$
$\|c\rangle$	$\frac{\|\downarrow\Uparrow\rangle + \|\uparrow\Downarrow\rangle}{\sqrt{2}}$	$\|\downarrow\Uparrow\rangle$	$E_c = \frac{a}{4}\left[-1+2\sqrt{1+\frac{4\left(\mu_e + -\mu_{\bar{p}}\right)^2 B^2}{a^2}}\right]$
$\|d\rangle$	$\|\downarrow\Downarrow\rangle$	$\|\downarrow\Downarrow\rangle$	$E_d = \frac{a}{4} - \left(\mu_{e+} + \mu_{\bar{p}}\right)B$

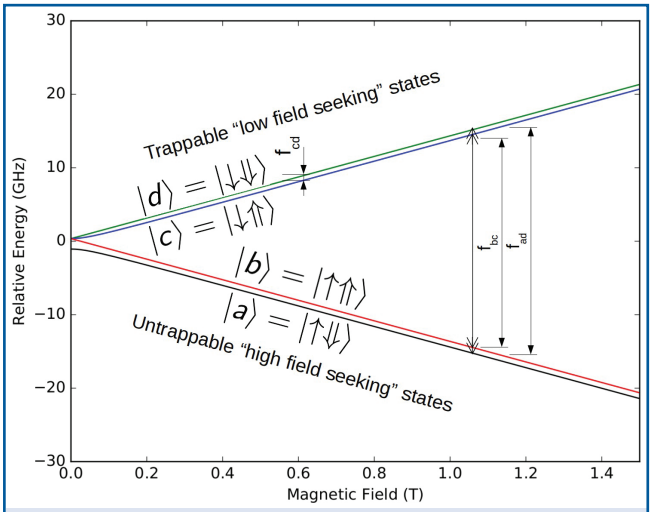

Fig. 1 The Breit-Rabi diagram for ground state antihydrogen, assuming CPT invariance, shows four states and their energies as a function of external magnetic field. We label the states in alphabetical order from the lowest energy states to the highest. The two positron spin flip transitions are labelled as f_{bc} and f_{ad}. f_{bc} is the frequency required to induce a positron's spin to flip from down to up, causing a transition from the $|c\rangle$ state to the $|b\rangle$ state. f_{ad} indicates the frequency required for the transition from the $|d\rangle$ to the $|a\rangle$ state. There is also one nuclear magnetic resonance transition labelled, f_{cd}, which refers to the spin flip of an antiproton.

Notice that atoms in only two of the four states, $|c\rangle$ and $|d\rangle$, are attracted to low magnetic fields. We call these the low field seeking atoms, and they are what we can trap. The atoms in high field seeking states get ejected from our trap and hit the walls of our apparatus where they annihilate. We can detect the products of that annihilation event. So, if we do induce a PSR transition from one of the two trappable states, the antiatom ejects from the trap and we detect an annihilation. This is what we do in our experiment; we scan the frequency of the microwave fields in the trap, from low to high, and count events as atoms are ejected from the trap. We intentionally start low and go up in frequency, so that when we hit the minimum energy needed for the transition, we see a sharp onset; below the onset, the frequency will be too low to be resonant with any atoms in the trap. Once we see a sharp onset in the lower transition and depopulate the $|c\rangle$ state antiatoms, we can jump up in frequency to the vicinity of the higher transition and repeat the scan. Here, we aim to measure the difference in the low-frequency onsets, rather than the absolute values, in order to extract a magnetic field independent measure of the hyperfine splitting. We have just completed a measurement of this quantity and find that the splittings in hydrogen and antihydrogen are different by no more than four parts in 10^{-3} [5].

I am going to summarize some future work that we have planned involving a study of nuclear magnetic resonance (NMR) transitions in antihydrogen.

Looking back at the Breit-Rabi diagram for ground state antihydrogen, I want to emphasize a different transition. In Fig. 1, we can see the transition frequency between $|c\rangle$ and $|d\rangle$ states. Since this involves a spin flip for the antiproton, we call this a nuclear magnetic resonance (NMR) transition. This transition will not cause an annihilation event; the atom would remain in a trappable state. Studying this transition is possible given that we are now confident that we can kick out all of one of the states; we could, for example, kick out all $|c\rangle$ state antiatoms, then irradiate the remaining $|d\rangle$ state antiatoms to try to induce NMR transitions to the $|c\rangle$ state. Then, we can clear the $|c\rangle$ state antiatoms again, and see if we succeeded in inducing any $|d\rangle$ to $|c\rangle$ transitions. This measurement is very promising, and could potentially provide one of the most stringent tests of CPT invariance.

The main reason it could bode so well for CPT invariance testing is due to its first order insensitivity to magnetic field. In order to explain this, I draw your attention to Fig. 2, where I plot the energy difference between the $|c\rangle$ and $|d\rangle$ states. Notice that there is a maximum at about 0.65 T. This zero derivative is what gives us a first order insensitivity to magnetic field, and is an ideal place to do the experiment. This coupled with the first order insensitivity to position that we get due to the trap being a magnetic minimum, should give us the ability to do precise measurements of the frequency of the transition as atoms pass through the centre of the trap. We anticipate being able to gain several orders of magnitude more precision compared to PSR transition measurements. At this level, we can start to probe the internal and magnetic structure of an antiproton.

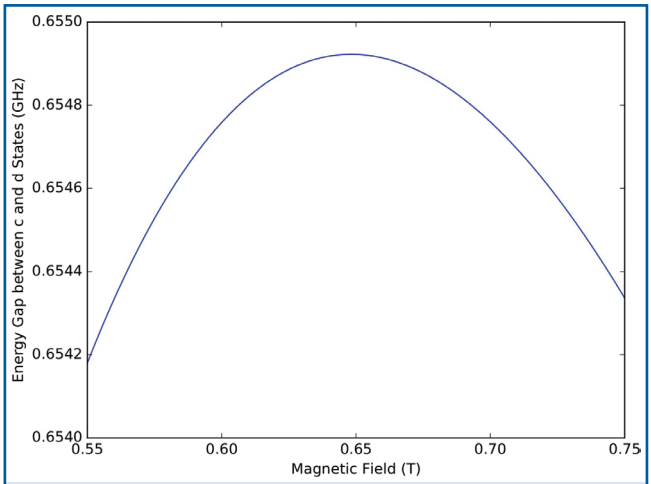

Fig. 2 The energy difference between the $|d\rangle$ and $|c\rangle$ states plotted as a function of external magnetic field. Notice the turning point at 0.65 T where the energy difference passes through a maximum. This is expected to give rise to a sharp spectroscopic feature in the transition frequency due to the first order insensitivity to external magnetic field.

ACKNOWLEDGEMENTS

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POSITION RECONSTRUCTION FOR DEAP-3600

BY CARL RETHMEIER[1] FOR THE DEAP-3600 COLLABORATION

SUMMARY

Position reconstruction is used in DEAP-3600 WIMP dark matter search experiment to discriminate impostor events from the detector surface and to locate candidate events.

WHAT IS DARK MATTER?

The existence of invisible, non-standard model matter, or "dark matter" has become well-established in recent decades. Perhaps the most well-known evidences are the distribution of the velocities of stars within galaxies as they revolve around the centre, and the velocities of the galaxies themselves as they revolve around the centre of galactic clusters. These stars and galaxies travel much faster than the gravitational force of the observable mass of these galaxies would allow. This led to speculation of extra invisible "dark matter" within the galaxies that would produce the extra gravitational force [1]. Other evidences, such as the collision of the Bullet Cluster (in which actual pockets of dark matter were observed through gravitational lensing), lend weight to this theory as opposed to a modification of Einstein's law of gravity [2].

Searches for MAssive Compact Halo Objects (such as stray planets, black holes, etc.), also known as MACHOs, have shown that there aren't enough of these in the galaxy to explain the missing mass [3].

Big Bang nucleosynthesis has shown that if dark matter is baryonic, the higher initial density of baryons during the Big Bang that would have been necessary to account for this extra matter would have resulted in a relative abundance of light elements that is inconsistent with the observed abundances. In fact, the observed abundances are consistent with Big Bang nucleosynthesis models that assume that dark matter is non-baryonic [1].

Models of the evolution of the universe show that the gravitational collapse of hot gas into stars and galaxies, the gas was so energetic that it would not have been possible to form the structures seen today without the presence of cold dark matter to effectively "boost" gravity [1].

Lastly, measurements of the multipole moments in the Cosmic Microwave Background (CMB) have also shown evidence for a non-baryonic dark matter component in the universe [4]. These observations have led to the conclusion that some particle (or particles) that is not included in the Standard Model is responsible.

SEARCHING FOR DARK MATTER WITH DEAP-3600

There is no evidence for any kind of interaction between dark matter and normal matter except through gravity. The fact that dark matter is invisible and appears to not interact with gases around it (such as in the Bullet Cluster), implies that it does not interact electromagnetically. If it interacted via the strong force, either protons would decay into it, or it would decay hadronically, depending on its mass. Since these interactions have not been observed, it appears that dark matter does not interact via the strong force.

However, the weak force is not ruled out. Weakly Interacting Massive Particles (WIMPs) are a leading theoretical candidate for dark matter [1]. If they exist they would interact very rarely with normal matter and would release very little energy in an interaction. So to make detection possible, it is necessary to construct an experiment that maximizes the probability of interaction, while minimizing the backgrounds that would mask or mimic the signal from the interaction. Noble gases are good targets for WIMP searches, due to their stability over time, lack of chemical reactivity, and good scintillation response.

DEAP-3600 is located 2 km underground at SNOLAB, in Sudbury, Ontario [5,6]. It uses liquid argon as the target mass, and is primarily an 85 cm acrylic sphere filled with liquid argon. The idea is that a dark matter particle will find its way into the liquid argon and scatter with an argon nucleus. This nuclear recoil will generate scintillation photons within the liquid argon. These photons will be emitted isotropically from the interaction site and propagate to the edge of the sphere, where acrylic light guides will transport the wavelength shifted argon scintillation light to the 255 photo-multiplier tubes (PMTs) that surround the acrylic vessel. To shift the 128 nm scintillation light to blue light that can travel through acrylic, a layer of tetraphenyl butadiene (TPB) coats the inner surface of the acrylic vessel. See Fig. 1 for a diagram of the detector and

1. Carl Rethmeier received 1st place in the CAP Best Student Poster Presentation competition at the 2017 CAP Congress at Queen's University in Kingston, ON.

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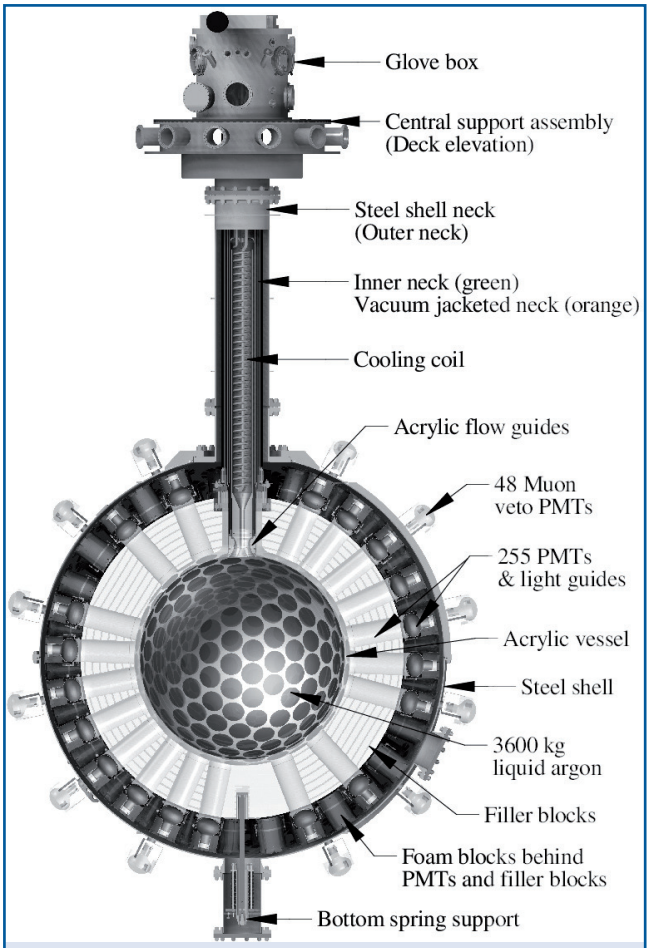

Fig. 1 Annotated cross-section of the 3D CAD schematic of the DEAP-3600 detector, showing the acrylic vessel, light guides, and PMTs.

[7] for more details on the TPB, including its deposition, testing, and performance.

The primary observable in DEAP-3600 is the distribution of charge collected by the PMTs, which is proportional to the number of photons detected. For the WIMP events DEAP-3600 is sensitive to, this is expected to be approximately 80-240 photons.

POSITION RECONSTRUCTION

Motivation

When particles interact with liquid argon they excite the argon atoms into long-lived triplet (1600 ns) and short-lived singlet (6.7 ns) spin states. The ratio of singlet to triplet states depends on whether a given incoming particle recoiled off an electron (via an electromagnetic interaction) or the nucleus (as WIMPs are expected to do). This allows for a very strong discrimination of electron recoil background events. This is essential for argon dark matter searches, since the naturally occurring radioactive ^{39}Ar (a beta emitter) would otherwise drown out any dark matter signal.

However, there will always be some level of radioactivity within the detector from alpha decays. Alpha particles tend to recoil off the nuclei of argon atoms. This is not normally an issue, as alpha particles release orders of magnitude more energy when they scatter than a WIMP would. An exception to this is the case when an alpha particle is produced in the TPB or acrylic bulk. Occasionally, the alpha particle will lose just enough energy in the TPB before entering the argon that it ends up producing a nuclear recoil in the energy range of interest for the WIMP search.

Fortunately, these alphas don't penetrate very far into the liquid argon volume. They can therefore be excluded from the WIMP search data by ignoring all events that occur within a certain distance from the surface of the acrylic vessel. In order to accomplish this, it is necessary to have a reliable position reconstruction algorithm to find the positions of events within the detector.

Fitters

There are three preliminary position reconstruction fitters currently being evaluated by the collaboration. They are: "Centroid", "MBLikelihood", and "ShellFit". These fitters have shown promise in terms of both their resolution and accuracy. Monte Carlo studies have shown that the resolution is better than 20 cm throughout the detector, and is even better near the edge.

CENTROID

Centroid is not as much a fitter as a weighted average. The charge on each PMT is scaled up by a power, *f*.

$$Q_{scaled} = Q^{f} \tag{1}$$

This power factor is pre-set, and is intended to be tuned on ^{39}Ar calibration data. As it loops through the PMTs, the scaled charge is multiplied by the PMT position (**P**) and added to an overall Centroid position vector (**C**).

$$C = \sum_{i=1}^{nPMT} P_i \times Q_{scaled,i} \tag{2}$$

Once this is done, **C** is divided by the total scaled charge, resulting in a final weighted average for the location of the charge. This is the value returned by Centroid. Centroid's simple algorithm makes it well suited for sanity checks of the Monte Carlo, as any unexpected artefacts in the spectrum of reconstructed position are unlikely to originate from defects in the algorithm. It is currently being used to further calibrate the Monte Carlo optical model, for example. The power, *f*, has been calibrated on ^{39}Ar data, and a value of 3 was found to give the highest position resolution. A good resolution increases the effectiveness of using this tool to calibrate the Monte Carlo.

MBLIKELIHOOD

MBLikelihood is a negative log likelihood fit of the charge distribution. A Monte Carlo based tuning algorithm creates the likelihood function that is used by this fitter. This depends on the state of the Monte Carlo model at the time of tuning, so it is necessary that the Monte Carlo is calibrated as well as possible.

SHELLFIT

ShellFit performs Monte Carlo simulations on an event-by-event basis to determine the position of events within the detector. It uses Centroid to get a position estimate for an event, and then generates a series of Monte Carlo events in that region. A negative log likelihood minimization is then used to converge on the most likely position of an event.

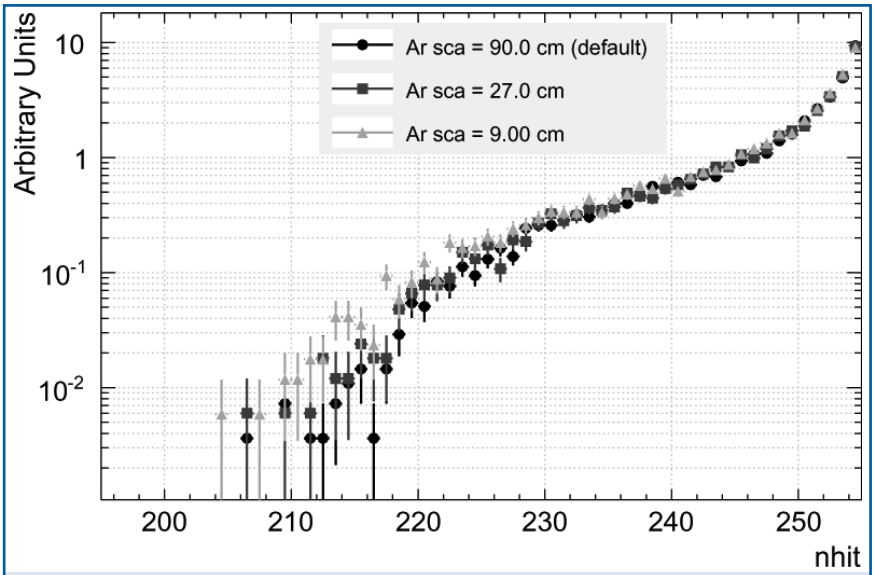

Fig. 2 Effect of scattering length on the total number of PMTs hit.

POSITION RECONSTRUCTION - CALIBRATION

Monte Carlo studies have also shown that the fitters perform well in discriminating events that occur near the acrylic surface. All that is needed, therefore, is to ensure that the algorithms perform as well on surface events in data as they do on Monte Carlo.

To ensure that the Monte Carlo is a sufficiently good representation of the data, it will be necessary to calibrate the models used in the Monte Carlo using various calibration sources. Calibration sources include a laser ball, the "Acrylic and Aluminium Reflector and Fibre optic-System" (AARF), external AmBe and 22 Na sources, and the radioactive internal ^{39}Ar that exists naturally in the liquid argon that fills the detector.

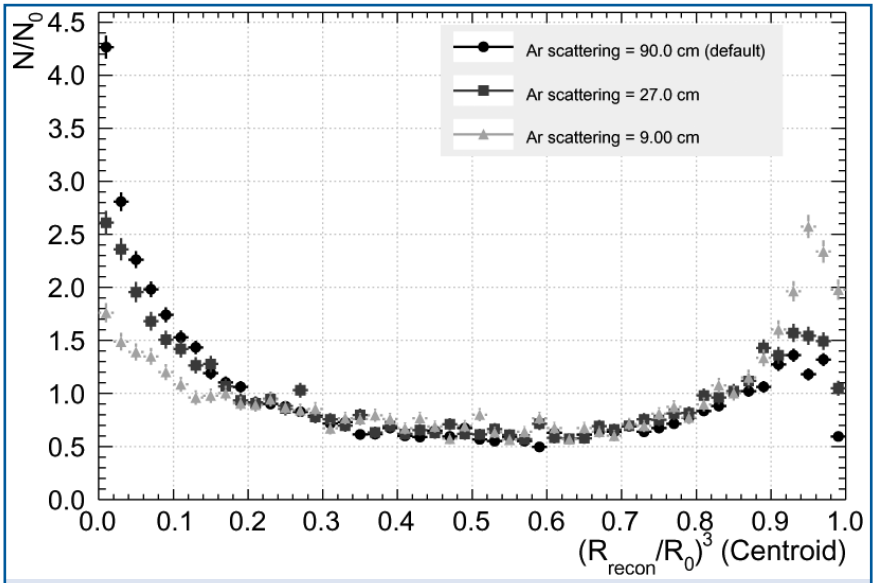

Fig. 3 Effect of scattering length on the reconstructed positions using the Centroid algorithm.

We will focus here on the ^{39}Ar, as it is a high rate background that is always present in the data. This allows for an in-situ comparison between the data and Monte Carlo model at any point in time while argon is in the detector.

This distribution is characterized by several variables used in the analysis. One such variable is "nhit", which is the number of PMTs that record pulses during an event.

By comparing the characteristics of the ^{39}Ar events seen in data with simulated ^{39}Ar events it will be possible to test and tune various parameters of the Monte Carlo model. One such parameter is the argon scatttering length. The argon absorption length depends strongly on the purity level of the argon, making measurements of the scattering length very difficult. Since this affects the diffusivity of light within the argon, getting this parameter (or others like it) wrong could bias the reconstructed positions of events.

All parameters used in the DEAP-3600 analysis are initially based on values found in the literature. Tuning these parameters

on data is mostly a matter of trying extreme values for a given parameter and seeing whether changing this parameter will bring about a closer match between the simulated calibration events and actual calibration events. Figures 2 and 3 show how the scattering length affects nhit and Centroid. These figures show how different extreme values of a given parameter might affect the characteristics of the observed signal.

An actual calibration would consist of a similar approach, with the main difference being that all parameters would need to be investigated in order to properly understand how the calibration of the Monte Carlo would affect the final analysis.

CONCLUSION

Once the development and calibration of these fitters is complete, DEAP-3600 will gain a significant boost in sensitivity, as this will enable it to utilize much more of its argon volume while still excluding radioactive surface backgrounds. These techniques might also be applied in future large scale WIMP searches, and may one day contribute to the discovery of these mysterious particles.

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DECOHERENCE RESULTING FROM THE GRAVITATIONAL INTERACTION BETWEEN TWO QUANTUM OBJECTS

BY JACK DAVIS[1], ROBERT B. MANN, AND ALEXANDER R.H. SMITH

All quantum systems continuously interact with their environments and are fundamentally inseparable from them. As a result of this interaction, information about the system is irreversibly lost to the environment, which can cause the coherence (i.e., the 'quantumness') of the system to decrease over time. This process is known as decoherence.

While the phenomenon of decoherence is essential in understanding the quantum-to-classical transition, this phenomenon only became a mainstream subject of study in the 1980s [1, 2]. Still an active area of research however, decoherence is the process that a general quantum system undergoes when the quantum property of superposition in a particular basis is suppressed. As a result of interacting with its environment, a quantum system initially prepared in a spatial superposition may decohere into a mixed state, and the observability of the superposition, say in an interference experiment, will decrease over time.

Recent experimental progress has given rise to the possibility of performing experiments involving massive quantum systems in superposition. Specifically, in the field of cavity optomechanics it has been suggested that massive levitated nano-particles may be prepared in macroscopically distinct spatial superpositions [3]. Such advances have the potential to test different models of gravitationally induced decoherence [4-7].

In this article, we model these nano-particles as Gaussian wave packets and superpositions of Gaussian wave packets. We consider two of these particles interacting with each other under their own gravitational influence. Treating one of the particles as the environment, we study the decoherence process of the other particle which is initially prepared in a spatial superposition. We observe that over time this spatial superposition is suppressed and, as a measure of non-classicality, we compute the purity of this particle and observe its decrease in time.

SUMMARY

Quantum particles are modelled as Gaussian wave packets and the decoherence process resulting from the gravitational interaction between two such wave packets is studied.

GAUSSIAN WAVE PACKETS AND 1-DIMENSIONAL GRAVITY

We consider two quantum particles of equal mass separated by a distance R in 1 dimension. The first particle begins in a spatial superposition of two Gaussian wave packets, the size of the superposition being Δ. The second particle begins in a Gaussian wave packet and acts as the environment seen by the first particle. This setup is depicted in Fig. 1. Note that R and Δ are measured in units corresponding to the width of the wave packets, which in the cases considered are identical.

The composite system of the two particles evolves under the influence of their own gravitational interaction. This evolution is described by the Hamiltonian

$$H = \frac{p_1^2}{2m_1} + \frac{p_2^2}{2m_2} + Gm_1m_2\left|x_2 - x_1\right|, \qquad (1)$$

where G is Newton's constant in 1-dimension and m_1 and m_2 are the masses of the two particles and are chosen to be equal. The first two terms appearing in the Hamiltonian above describe the free evolution of the particles and the last term describes their gravitational interaction[2]. This evolution is simulated in Mathematica following the methods outlined in [8].

Denoting the initial state of the composite system of the two particles as $\rho_1(0) \otimes \rho 2(0)$, the reduced state of particle 1 at a later time t is given by

$$\rho_1(t) = \mathrm{tr}_2\,[U(t)\rho_1(0) \otimes \rho_2(0)U(t)^\dagger], \qquad (2)$$

where $U(t) := e^{-iHt}$ is generated by the Hamiltonian given in Eq. (1). The magnitude of the matrix elements in the position basis $|\langle x|\rho_1(t)|x'\rangle|$ are plotted in Fig. 2 at four different times; the diagonal elements lie along the line $x = x'$ and the off diagonal elements lie along the line $x = -x'$. As

1. Jack Davis tied for 2nd place in the CAP Best Student Poster Presentation competition at the 2017 CAP Congress at Queen's University in Kingston, ON.
2. Recall that in D spatial dimensions the Newtonian gravitational potential is proportional to $|x2 - x1\,|2\text{-}D$. Alternatively, the 1-dimensional case considered in Eq. (1) may be thought of as two infinite parallel plates interacting in 3-dimensions.

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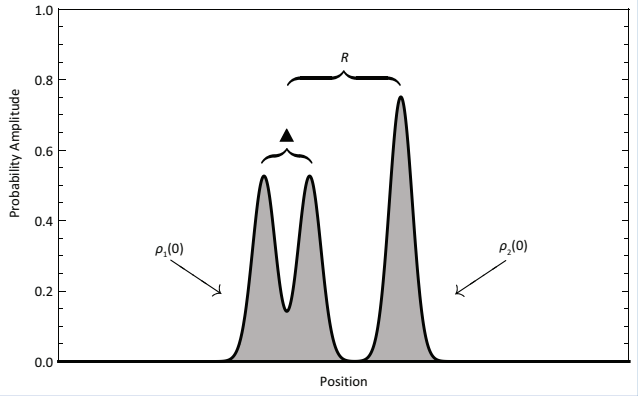

Fig. 1 Initial spatial wave functions of the two interacting particles.

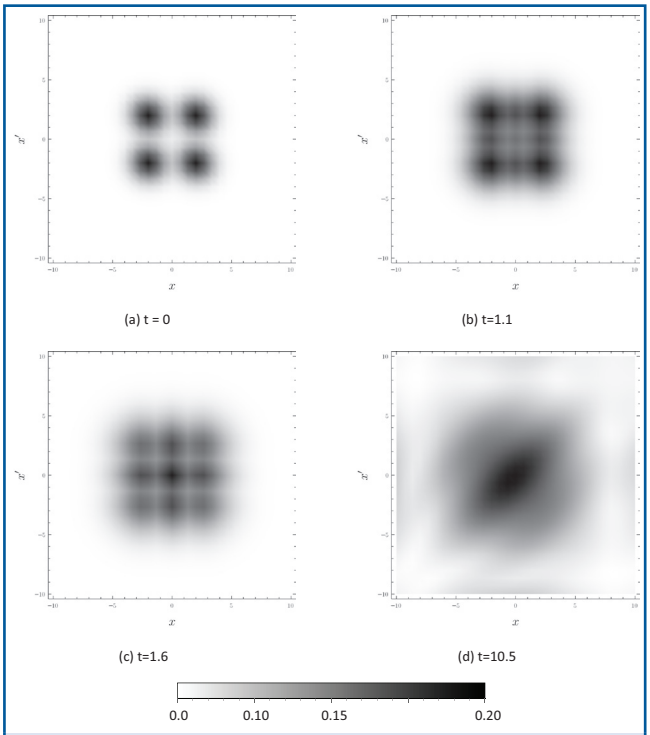

Fig. 2 The magnitude of the reduced density matrix in the position basis $|\langle x|\rho_1(t)|x'\rangle|$ is plotted at four different times. The separation of the particles is $R = 10$ and the size of the spatial superposition is $\Delta = 4$.

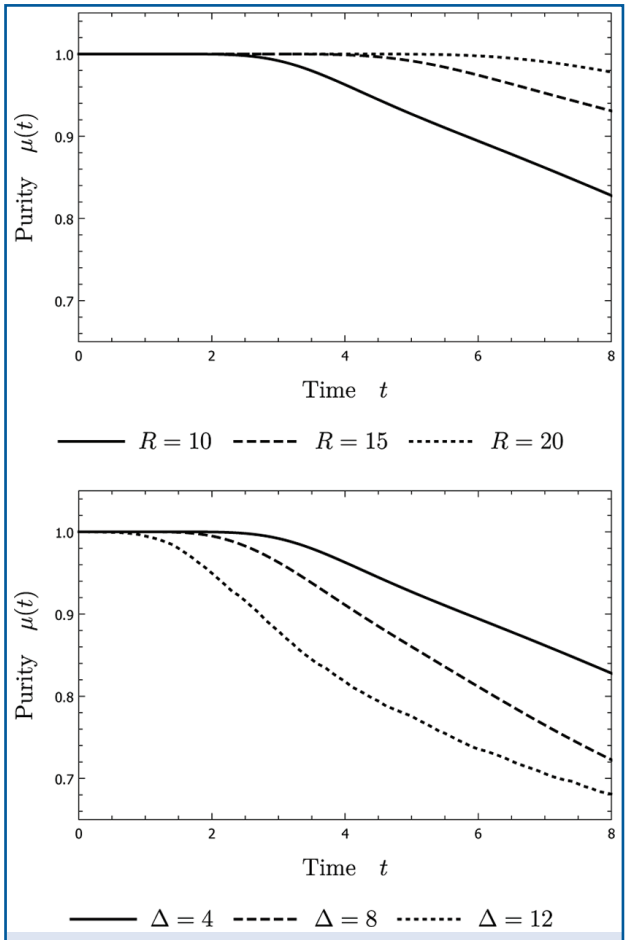

Fig. 3 The purity $\mu(t)$ is plotted as function of time for (a) different particle separations R and (b) for different sizes of superposition Δ. The solid line in both (a) and (b) corresponds to the values $R = 10$ and $\Delta = 4$.

time progresses we see that the off diagonal elements are suppressed and thus observe that the gravitational interaction between the two particles causes spatial superposition of particle 1 to decohere.

The evolution described by the Hamiltonian in Eq. (1) entangles the two particles. As a result, when the second particle acting as the environment is traced out, the reduced state of particle 1 given in Eq. (2) is mixed. To quantify how mixed particle 1 is we compute the purity associated with $\rho_1(t)$; the purity is defined as $\mu(t) := \text{tr}\,[\rho_1(t)^2]$. In our particular case, $\mu(t)$ takes values between 1 (pure state) and 0 (completely mixed state). The purity is an indicator of the non-classicality of the state of a system [2], and its decrease is a signature of the onset of decoherence.

In Fig. 3 we plot the purity of particle 1 as a function of time for several sizes of superposition Δ and separation R of the two particles; by construction the purity of particle 1 at $t = 0$ is $\mu(0) = 1$. In all cases we observe that the purity decreases over time. We find the closer the particles are (smaller R) and the larger the size of the superposition of particle 1 (bigger Δ), the quicker the purity of particle 1 decreases.

It is interesting to note that classically in 1-dimension, particles moving under their mutual gravitational interaction only care about the orientation of the particles with respect to one another

and not their separation[3]. However, as we observe in Fig. 3, quantum properties like the purity care about both the distance the particles are away from each other and the quantum states (i.e., superposition) of the particles.

CONCLUSIONS

In summary, we have begun investigating how quantum properties are affected by the Newtonian gravitational interaction between quantum particles with an eye on realizing these effects in near future experiments. Future work will include exploring other experimentally accessible measures of non-classicality, generalizing the above analysis to 3-dimensional Newtonian gravity, and modelling corrections to the decoherence process predicted by alternative collapse theories [9].

ACKNOWLEDGEMENTS

The authors would like to thank the Canadian Association of Physicists for the opportunity to share this work in Physics in Canada. This work was supported by NSERC and the Ontario government.

3. For the case at hand, the gravitational force exerted by either particle on the other is

$$F := -Gm_1m_2\nabla|x_2 - x_1| = \text{sgn}\,(x_2 - x_1)Gm_1\,m_2,$$

which is independent of the particle separation.

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Fraser A. Duncan (1962 - 2017)

On February 4th 2017, SNOLAB, Queen's University, and Canada lost a dedicated colleague, leader, mentor, and physicist. Born in 1962, Fraser Duncan graduated from schools in Mission, BC, then went on to study Engineering Physics at UBC, in the Electrical Engineering option. After working on the construction of TRIUMF's Secord Arm magnetic Spectrometer (SASP), Fraser went on to a Ph.D. at UBC studying non-resonant pion production with proton beams on neutrons using a liquid deuterium target. He then went to the University of Maryland for a postdoctoral position based at Thomas Jefferson National Laboratory where he worked on parity-violating electron scattering as a probe of nucleon structure.

Fraser started his career in underground physics joining the Queen's University Subatomic Physics group in 1997 to work on the SNO experiment. Fraser quickly took leadership of the calibration sources and hardware development at Queen's, and coordinated much of the calibration efforts across the experiment. He developed the mechanically complex manipulator system that provided deployment and hoisting of sources within the SNO detector acrylic vessel with three-axis motion and precision relocation. The prototypes were systematically tested from a garden shed cantilevered over the edge of the roof of the physics building. His ability to get things built and working came from his attention to details, and skill in design, mechanical assembly, electronics, and the software and controls. Fraser was also meticulous in his documentation of hardware, drawings, procedures and plans. Fraser then became Detector Manager for SNO in 2001, coordinating and managing detector operations, directing run time schedules and optimisation, calibrations, maintenance and emergencies, and seeing the detector through the critical salt-addition phase and installation of the 3H neutral-current detectors. He wrote the original software package for SNO to perform the neutrino physics analysis, and performed the first global solar neutrino oscillation analysis. From 2004 he was appointed deputy SNO Director, a roll he filled to the end of the SNO experiment, responsible for the day-to-day operations and maintenance of the underground site.

Fraser's experience in underground operations took him to the role of Associate Director SNOLAB in 2004, a responsibility he held concurrently with management of the SNO facility. A sharp scientist with broad engineering experience, Fraser was immersed in every design detail of the SNOLAB facility. Much of SNOLAB came to be, because Fraser had the insight, from air handlers, ducting design, chiller systems, piping, firewalls, electrical distributions, cable-trays, compressed air, rail lines, showers and laundry – Fraser thought through everything. Participating in all experiment reviews, Fraser was the gatekeeper for underground installations, ensuring his high standards for science merit, proper engineering, installation planning, project management, quality control, and above all safety. Fraser loved to tour visitors; and while he joked about it being like herding cats, he was always a warm host, inspiring and educating, while proudly showing off the laboratory and the experiments, and delighting in the stories and details as to why thing were. He was also an avid photographer, an much of the SNOLAB image documentation and catalogue is due to his effort.

Of course besides all his accomplishments, it's the person we remember most. Unassuming in his casual grey sweatshirt uniform, with his dry sense of humor, he was a firm leader, absolutely professional, yet also a greatly empathetic and kind manager. He lead by example, and felt particular responsibility for students, whether watching over them in the lab, detailed reading of their work, driving them to SNOLAB, or bringing gas to a stranded car in the middle of the night. Yet Fraser was always a very private person, and few knew he was a pilot, loved jazz, Celtic and new age music, had a sweet tooth for chocolate, and was very fond of single malt scotch.

With tremendous insight, Fraser had his hand in everything at SNOLAB, and we miss him greatly.

Richard Ford and Chris Jillings, on behalf of all his SNOLAB friends and colleagues

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CAP-TRIUMF Vogt Medal for Contributions to Subatomic Physics

La Médaille Vogt de l'ACP-TRIUMF pour l'excellence en physique subatomique

Much is understood about the theory of the nuclear strong interaction, QCD (Quantum Chromodynamics), but far less is known about its behaviour at extreme conditions of temperature and density. What happens deep in the interior of neutron stars? What did the universe look like, only a few microseconds after the big bang? To provide answers to questions like those, a vigorous experimental program based on colliding heavy nuclei at large energies is currently under way at the Relativistic Heavy Ion Collider (RHIC) and at the Large Hadron Collider (LHC). Charles Gale's theoretical work has been used to motivate and interpret several generations of experimental collaborations. He has made many seminal contributions to the theory of relativistic heavy ion collisions, to finite-temperature field theory, and to relativistic many-body physics in general. Professor Gale is renowned for his work on the emission of electromagnetic radiation in high-energy nuclear collisions, for calculations of observables connected to the nuclear equation of state, and for development and use of relativistic viscous hydrodynamics to model the plasma of quarks and gluons created during the interaction of energetic nuclei. He is the author of more than 225 peer-reviewed papers, and he has also co-authored a textbook on field theories at finite temperature which has become a standard reference; it is being used by practitioners of nuclear and particle physics, and of astrophysics.

The 2017 CAP-TRIUMF Vogt Medal for Contributions to Subatomic Physics is awarded to Prof. Charles Gale, McGill University, for advances in theoretical nuclear physics including the theory and modelling of high-energy nuclear collisions.

La Médaille Vogt de l'ACP-TRIUMF pour l'excellence dans le domaine de la recherche théorique ou expérimentale en physique subatomique 2017 est décernée à Charles Gale, Université McGill, pour ses avances en physique nucléaire théorique, y compris sur le plan de la théorie et de la modélisation des collisions nucléaires de haute énergie.

Remarks by Charles Gale

It is an honour to be chosen as this year's recipient of the CAP-TRIUMF Vogt Medal for Contributions to Subatomic Physics. I have met Erich Vogt a few times in my career, and on each of those occasions I have been struck by his energy and his determination to promote science in general and Canadian science in particular. I feel fortunate to be associated with an award bearing his name.

Much of my work deals with the theoretical physics of strongly interacting matter in extreme conditions of temperature and density such as those that pervaded the Universe only a few microseconds after the Big bang. These exotic conditions can be recreated in the laboratory by studying the relativistic collisions of nuclei. As such, this research topic unites subatomic physics with astrophysics and cosmology: the physics of what happens at an infinitesimal scale influences and even regulates the large-scale behaviour of our world.

Recipient of the 2017 Medal / Lauréat de la médaille 2017:

Charles Gale

The physics of "heavy-ion collisions" has entered a Golden Age and now benefits from a wealth of data garnered at leading facilities around the world such as RHIC (the Relativistic Heavy-Ion Collider, at Brookhaven National Laboratory), and the LHC (the Large Hadron Collider, at CERN).

Those measurements have fueled important developments in theory. For instance, we now know that the quark-gluon plasma formed in those energetic collisions flows like a liquid with a specific shear viscosity smaller than that of any known substance. We also know that QCD jets propagating in the quark-gluon plasma will lose much of their energy, and that this quenching is quite revealing of the relativistic many-body physics occurring at the interface between the jet

and the medium. At McGill, I am proud to report that our group has made important contributions to those topics. In addition, we have invested effort to understand how the plasma shines electromagnetically, and how this signal can tell us about the first fleeting moments of its existence. We have shown that photons, leptons, and hadrons calculated and analyzed in a holistic approach can indeed reveal features of the strong interaction that had remained elusive up to now. These are exciting times to be a subatomic theorist.

"Canada has a long and illustrious tradition of research in subatomic physics, and I am deeply honoured to have been chosen as this year's recipient of the CAP-TRIUMF Vogt medal. I thank all of my collaborators, and I am thrilled to share this recognition with them."

"Why do I enjoy doing this?", I asked myself as I was about to write these lines: I don't think every day about why I like doing what I do. After some introspection, I find this topic appealing as it straddles nuclear and particle physics, and combines subatomic physics with aspects of statistical physics, field theory, numerical modeling and simulation. Here, the many colours in the theory palette contribute to paint a rich picture.

« Le Canada a une longue et brillante tradition de recherche en physique subatomique et je suis fort honoré d'avoir été désigné lauréat de la Médaille Vogt de l'ACP-TRIUMF cette année. Je remercie tous mes collaborateurs et suis très heureux de partager cette reconnaissance avec eux. »

Early on, I have been fortunate to meet mentors whose passion has stayed with me. Among them, I am happy to name Subal Das Gupta, Joe Kapusta, George Bertsch, and Gerry Brown.

Finally, I have been blessed with patient collaborators and outstanding students and postdocs from whom I have learned much; I am happy to share this medal with them.

CAP-CRM Prize in Theoretical and Mathematical Physics

Le Prix ACP-CRM de physique théorique et mathématique

Recipient of the 2017 Prize / Lauréat du prix 2017:

Raymond Laflamme

Raymond Laflamme completed his PhD on aspects of general relativity and quantum cosmology in the Department of Applied Mathematics and Theoretical Physics (DAMTP) under the direction of Professor Stephen Hawking at the University of Cambridge. From 1992-2001, Dr. Laflamme worked as a research scientist at Los Alamos Research Laboratory, where his interests shifted from cosmology to quantum computing. His work in this new area has focused on how to make quantum information processors more feasible.

The 2017 CAP-CRM Prize in Theoretical and Mathematical Physics is awarded to Dr. Raymond Laflamme, IQC/University of Waterloo for his ground-breaking contributions on quantum information.

Le prix ACP-CRM de physique théorique et mathématique 2017 est décerné à Raymond Laflamme, IQC/Université de Waterloo, pour ses apports innovateurs en information quantique.

Since the mid-1990s, he has developed theoretical approaches to quantum error correction, and has given experimental demonstrations of these techniques. In collaboration with Emmanuel Knill, Dr. Laflamme gave conditions for quantum error correcting codes, and established the fault-tolerance threshold, thereby showing that quantum computing systems could be practically useful. He went on to perform the first experimental demonstration of quantum error correction. Dr. Laflamme has also devised and implemented new methods to make quantum information robust against corruption in both cryptographic and computational settings. With colleagues, he has developed a blueprint for a quantum information processor using readily available linear optic components rather than exotic nonlinear devices. This work was recognized as one of the most influential achievements in quantum information in the period 2001-2009.

Dr. Laflamme holds the Canada Research Chair in Quantum Information and has authored or co-authored over 170 academic papers. He also co-authored a book, Introduction to Quantum Computing, with Michele Mosca and Philip Kaye in 2006. Dr. Laflamme founded the Institute for Quantum Computing in 2002 and has been its Executive Director since its inception.

Remarks by Raymond Laflamme

It is a true honor to receive the 2017 CAP-CRM Prize in Theoretical and Mathematical Physics.

It is a very special to me, in particular because, when I was a student in the mid 1980s, Werner Israel used to visit the group I belonged to in Cambridge. I remember with great pleasure discussions with him about the work he was doing. Werner is an inspiring figure and I looked up to him wandering what would the future hold for me when I reach his seniority. Werner was the first CAP-CRM Prize in Theoretical and Mathematical Physics, so I am deeply honored to join him and many of my colleagues in this group of distinguished researchers.

"As a student in Cambridge, Professor Werner Israel regularly visited Professor Stephen Hawking. I remember looking up to him as an eminent scientist and someone to emulate. Being considered alongside Werner and the impressive group of researchers awarded the CAP-CRM prize in the past, is truly an honour."

Quantum mechanics was discovered more than a hundred years ago. For its first 50 years, it was similar to astronomy: a descriptive science successfully explaining observations, but since the 1950 however research in quantum mechanics went from what I would call a passive to an active science, one where technologies have been created that are based on quantum effects: the laser, magnetic resonance imaging, the transistor.

The trend to shrink the size of transistor in the last 50 years, has been such that we are reaching the limit of atomic size where quantum effect become pervasive. Quantum effects can be turned into an advantage leading to the discovery of computers based on the laws of quantum mechanics with powers which is shattering the foundation of computer science, of unbreakable cryptographic systems, of new methods of for time keeping, lithography and other technologies.

Quantum information processing promise to develop devices that are more powerful than their classical counterparts. It does so by encoding and manipulating information in states that are either difficult or impossible to reach classically. Unfortunately these states are typically extremely fragile. To turn the ideas of quantum information processing into reality, we need to make quantum information robust to imperfection and imprecision inherent to realistic devices. In the mid-1990s, a theory of quantum error correction was discovered and accuracy threshold theorems were proved showing that error can be controlled using a reasonable amount of resources as long as the error rate is smaller than a certain threshold. I have contributed to these discoveries both at the theoretical and experimental level leading to a theory demonstrating how to control quantum systems in a scalable way. This is opening the way to develop quantum technologies that will have societal impact.

« À titre d'étudiant à Cambridge, je me rappelle que je considérais le professeur Werner Israel, qui visitait régulièrement le professeur Stephen Hawking, comme un éminent scientifique et une personne à prendre pour modèle. Le fait d'être considéré en parallèle avec Werner et l'impressionnant groupe de chercheurs qui ont déjà été lauréats du prix de l'ACP-CRM est un véritable honneur. »

I am grateful to my mentors and colleagues that have helped me during the many years when this research was accomplished. I would also like to thank my wife Janice and my children Patrick and Jocelyne, who support me in the good days and the challenging ones, and for teaching me the intuitive approach to error correction.

CAP-COMP Kirkby Medal

La Médaille commémorative Peter Kirkby de l'ACP-OCPM

Recipient of the 2017 Medal / Lauréat de la médaille 2017:

Jerry J. Battista

Dr. Battista is an award winning Medical Physicist based in London, Ontario, Canada. He serves as the Director of Physics Research and Education at the London Regional Cancer Program and the past Chairman of the Department of Medical Biophysics at Western University in London, Ontario, Canada. Dr. Battista has supervised a number of graduate students who have become international stars in the world of radiation therapy physics.

The resultant new technologies developed by them are now used worldwide as part of highly precise image-guided radiation therapy – the modern standard of practice. Dr. Battista is known for excellent communication skills that have resulted in multiple teaching awards, including receiving top honours at Western University. He is known for successful use of analogies bringing complex subjects to understandable levels. Furthermore, his research supervision of graduate students has resulted in award winning research papers both in the Canadian and broader international medical physics communities.

The 2017 CAP-COMP Peter Kirkby Memorial Medal is awarded to Jerry J. Battista, Western University, for his outstanding and lifelong contributions to Medical Physics in Canada that have fundamentally altered worldwide practice. In addition to being an outstanding teacher, researcher, and mentor, Dr. Battista has steadfastly advocated for his field through his work on many professional and accreditation committees, his service as an advisor to the Ontario Ministry of Health and Cancer Care Ontario, and his coordination of Canada's largest residency training program in clinical physics.

La Médaille commémorative Peter Kirkby de l'ACP-OCPM 2017 est décernée à Jerry J. Battista, Université Western, pour les contributions exceptionnelles de toute sa carrière à la physique médicale au Canada qui ont fondamentalement modifié la pratique mondiale. Outre sa qualité d'enseignant, chercheur et mentor exceptionnel, le Dr Battista a défendu farouchement son domaine par son travail auprès de nombreux comités professionnels et d'agrément, par son service comme conseiller du ministère ontarien de la Santé et des Soins contre le cancer et sa gestion du programme de formation de résidence spécialisée en physique clinique.

For many years, Dr. Battista has also served as the coordinator of the Medical Physics residency training program for the Province of Ontario. This program has long served as the model of medical physics education and training such that the graduates are highly sought after in both Canada and the US. Dr. Battista's very positive and open attitude with his students, his peers and the general public epitomize what Peter Kirkby stood for — a vision of a strong physics community dedicated to efforts that support open communication, fairness and honesty.

Remarks by Jerry J. Battista

I was honoured to receive the 2017 Kirkby Award from the CAP and COMP organizations. I share it proudly with family, students, and colleagues in medical physics — past and present. I served as Chairman of the Division of Medical & Biological Physics (DMBP) in 1986-87, but did not have the pleasure of meeting Dr. Peter Kirkby. However, a mental image of this special individual has emerged from an article published in *Physics in Canada* (March/April 1995): meticulous care and attention to detail; proper documentation; respect for applied science; development of professionalism or risk extinction; continuity, consistency and fair play; promotion of science in young students; support of the community activities; hard-working; highly approachable individual. I admire and share many of these Kirkby traits. He also taught an interesting 'Physics for Poets' course to non-physics students. It is an activity that I also truly enjoy — minimizing "physics-o-phobia" by explaining physical principles of nature and technology that can be easily observed in everyday life.

"I am deeply honoured to receive the Kirkby memorial award. It spans the wide range of physics contributions to Canadian society, including radiation medicine. I follow in big footsteps of "Jack" Cunningham, an outstanding role model, and Erv Podgorsak, an educator and scientist with uncompromising attention to physics details. This is truly rewarding and inspiring."

« Je suis fort honoré de recevoir la Médaille commémorative Kirkby, qui englobe le vaste apport de la physique à la société canadienne, y compris en médecine des rayonnements. Je dois suivre les traces marquantes de « Jack » Cunningham, modèle de rôle exceptionnel, et d'Erv Podgorsak, enseignant et scientifique scrupuleusement attentif aux détails de la physique. C'est vraiment valorisant et inspirant. »

Medical physics is focused on the improvement and safety of diagnostic or therapeutic procedures. Physicists possess a unique education and thinking mode to advance these fields. This has catapulted the field up to 3D/4D imaging using ultrasound, computed tomography (CT), magnetic resonance (MRI), positron emission (PET), not to mention prior key biological discoveries using X-ray diffraction, electron microscopy, and lasers. Megavoltage linear accelerators are common in most cancer centres, equipped with 3D image guidance systems and beam gating. They deliver shaped dose distributions from x-ray or electron beams much more precisely — "hitting the cancer while missing the patient", as one of my clinical colleagues used to say. Looking ahead, one might anticipate that heavier particle accelerators (e.g., for carbon ions) might one day fit well within hospital budgets and space!

The mid-1970s was marked by ambivalence about the role of professional organizations as either common ground for individuals with similar scientific interest or as a

springboard for professional lobbying and recognition. The need for professionalism in hospital-based physics reached a crescendo when other specialists were recognized more firmly in provincial legislation. The malaise also cut across other sub-disciplines of physics, as highlighted and addressed by Dr. Kirkby who had a productive career in industry. External pressures were being felt mainly from engineering. The Canadian College of Physicists in Medicine (CCPM) was formed in 1979 and it has now certified over 425 clinical physicists. As Division Chair (1986-87), I was in the middle of a separatist movement leaning away from the parent CAP. An independent "Canadian Organization of Medical Physicists (COMP)" was eventually formed in 1989 and it now has over 850 members, mainly working in hospitals. The CAP biomedical division continues its activities as a parallel option for biophysicists.

The synergy between fundamental and applied research has always required a delicate balance and moderate level of friction to move forward. This is seen in today's research grant agencies; the pendulum keeps swinging between fundamental and applied science! Future discoveries in personalized radiation medicine will require interdisciplinary collaboration across physics, chemistry, and biology; nature hides its secret in combos. My advice to today's students is to understand physics as deeply and rigorously as possible, but embrace the diversity of exploration at the fringes of physics. The best is yet to come.

CAP Medal for Outstanding Achievement in Industrial and Applied Physics

Médaille de l'ACP pour des réalisations exceptionnelles en physique industrielle et appliquée

The 2017 Medal for Outstanding Achievement in Industrial and Applied Physics is awarded to Dr. Simon Fafard, Université de Sherbrooke, for his new developments covering 20 years of research in applied solid state Physics, coupled with his strong efforts in commercializing these through patents and the establishment of his own companies.

La Médaille de l'ACP pour des réalisations exceptionnelles en physique industrielle et appliquée 2017 est décernée à Simon Fafard, Université de Sherbrooke, pour ses avances couvrant 20 années de recherche appliquée en physique des solides, conjuguées à ses grands efforts visant à les commercialiser par des brevets et l'établissement de ses propres compagnies.

Recipient of the 2017 Medal / Lauréat de la médaille 2017:

Simon Fafard

A professor at the Université de Sherbrooke and an adjunct professor at the University of Ottawa, Dr. Simon Fafard's research focuses on advanced optoelectronics at the International Joint Unit "Laboratoire Nanotechnologies Nanosystèmes (LN2)" (CNRS, France/Université de Sherbrooke) and the "Institut Interdisciplinaire d'Innovation Technologique (3IT)" (Université de Sherbrooke). He is also President of Azastra Opto in Ottawa and Director of Scientific Partnerships for the "MiQro Innovation Collaborative Center (C2MI)", linking applied research and the rapid commercialization of microelectronic products. An expert in nanostructures, heterostructures, III-V semiconductor epitaxy, and optoelectronic devices, Dr. Fafard has led numerous key scientific contributions and technological innovations in the fields of material and renewable energy, with publications in prestigious scientific journals such as Science and Nature.

Dr. Fafard is the inventor of over 30 patents and the founder of various companies involved with solar energy and optoelectronic devices. He has raised over $20M of private and venture capital funding in addition to numerous research grants. Dr. Fafard is a recognized pioneer in nanostructures with a vast experience at the forefront of innovation, device development, and commercialization for various photonic and optoelectronic applications. This

helped Cyrium Technologies become a lead developer and manufacturer of one of the highest performance multijunction III-V solar cells and, more recently, has led Azastra to manufacture the highest performance III-V phototransducer products. This recent breakthrough, featuring the highest optical to electrical conversion efficiency ever for any type of devices, is now being presented at several invited international presentations.

As an entrepreneur, Dr. Fafard cumulates over 25 years of experience in optoelectronics and photonics, developing and commercializing numerous semiconductor devices and products in the industry at Azastra, Aton, Cyrium, Alcatel Optronics, Kymata, and also in research labs at Université de Sherbrooke, the National Research Council Canada and the University of California, Santa Barbara.

Remarks by Simon Fafard

I am very much honored to have been recognized by the Canadian physics community with the CAP Medal for Outstanding Achievement in Industrial and Applied Physics. Physics has always been my passion. In particular in the context of industrial applications, I trust that physics is the fuel for the innovations that drive todays' technology world. And, I have been determined to build organizations that can win and dominate a market segment and the only way to achieve this is by introducing new products. To be successful in the market place, such new products need to be competitive, and at the basis of the competitiveness there has to be some strong physical principles allowing enhanced device properties.

"I am much honored to be recognized by the Canadian physics community with the CAP Medal for Outstanding Achievement. Realizing successful applications in Industrial and Applied Physics is rewarding in itself. I feel very privileged to receive this award and I hope it inspires others to work hard in this area."

I feel indeed very privileged to have been one of the pioneers in the field of self-assembled quantum dots and nanostructures. My early work at USCB and at NRC allowed me to start to gain some vast experience at the forefront of physics and innovation. The device development and the related commercialization efforts followed for various photonic and optoelectronic applications. For example it allowed me to position Cyrium as lead developer and manufacturer worldwide with one of the highest performance multijunction III-V solar cells. And this turned out to be the basis that led Azastra to manufacture the highest performance III-V phototransducer products. I am very proud that our achievements enabled devices that are featuring the highest optical to electrical conversion efficiency ever.

Like every achievements, there is always a team working together and infrastructure to nurture the work. I would therefore like to thank Université de Sherbrooke for providing a great environment encouraging the entrepreneurship and innovation spirit. There I have been able to focus my research on advanced optoelectronics. This includes within the International Joint Unit "Laboratoire Nanotechnologies Nanosystèmes (LN2)" (CNRS, France/Université de Sherbrooke) and the "Institut Interdisciplinaire d'Innovation Technologique (3IT)" (Université de Sherbrooke). In particular of course I would like to thank all my co-authors on the technical contributions that we have made in the field, including Dr. Mark York, Prof. Vincent Aimez, Prof. Richard Ares, Prof. Karin Hinzer, Dr. Matt Wilkins, Dr. Christopher Valdivia, Lise Richard, and all my students and postdocs that contributed to the work, many others that contributed to the innovation. Substantial provincial, federal, and private funding have been invested and I grateful for all that trusted us with the research and development efforts. I have also been fortunate to be the Director of Scientific Partnerships for the "MiQro Innovation Collaborative Center (C2MI)", linking applied research and the rapid commercialization of microelectronic products. Centers like that are key to fostering innovation and bringing such innovations from ideas to achievements at an industrial level. And I am particularly proud to be part of a strong team of colleagues, as an adjunct professor at the University of Ottawa.

« Je suis très honoré d'avoir été fait lauréat de la Médaille de l'ACP pour réalisations exceptionnelles par la collectivité canadienne de la physique. Concevoir des applications fructueuses en physique industrielle et appliquée est valorisant en soi. C'est pour moi un privilège de recevoir ce prix et j'espère que cela en incitera d'autres à travailler fort dans ce domaine. »

Very importantly, want to thank my colleagues at Azastra, in particular Dr. Denis Masson with whom I co-founded Azastra which recently got acquired by Broadcom Limited, a large public company in the sector. I would also like to thank Francine Proulx and Philippe-Olivier Provost from Azastra for all their hard work and their countless contributions. Cyrium, the company in the solar cell business that I founded earlier, was also key in making outstanding achievements in the important field of solar cells. I would therefore also like to thank Dr. Norbert Puetz, Dr. Bruno Riel, Dr. Steven Wallace, Ing. Eric Desfonds, Dr. Sarah Langstaff, Aline Rugwizangoga, David McMeekin, and Allan Moore.

On a personal level, I believe that, like Steve Jobs once said, the only way to be truly satisfied is to do what you believe is great work, and the only way to do great work is to love what you do. I love physics and I love what I do! Realizing successful applications in Industrial and Applied Physics is rewarding in itself. But I feel very privileged to receive this award and I hope it inspires others to work hard in this area.

CAP Medal for Excellence in Teaching Undergraduate Physics

Médaille de l'ACP pour l'excellence en enseignement de la physique au premier cycle

Admired by colleagues and students alike for his unparalleled dedication to the thousands of undergraduates he has taught, Martin's enthusiasm and passion for teaching physics are truly inspirational. Martin's skills in the large lecture hall are exceptional: he successfully turns an auditorium seating 500+ students into a dynamic, engaging setting for student-focussed learning, incorporating countless innovative strategies from current research in physics education. Martin has contributed to the betterment of physics education through his commitment to all students at the University of Guelph, his scholarly work leading to the publication of books and journal articles, his design and development of new approaches to fundamental undergraduate physics courses, as well as his service to the community through his involvement in the executive of the Division of Physics Education at the CAP and the Ontario Association of Physics Teachers (OAPT). Martin Williams is a truly deserving recipient of the CAP Medal of Excellence in Teaching Undergraduate Physics.

The 2017 CAP Medal for Excellence in Teaching Undergraduate Physics is awarded to Dr. Martin Williams, University of Guelph for his exceptional ability to lead students to high academic achievements in physics through excellence and innovation in teaching and mentoring, for his contribution to curriculum design inspired by the results of Physics Education Research, and for his leadership in promoting the adoption of innovative research-based instructional strategies within the Canadian physics education community.

La Médaille de l'ACP pour l'excellence en enseignement de la physique au premier cycle 2017 est décernée à Martin Williams, Université de Guelph, pour sa capacité exceptionnelle à mener ses étudiants à des résultats élevés en physique par l'excellence et l'innovation en enseignement et mentorat, pour sa contribution à la conception de programmes inspirée des résultats de la recherche sur l'enseignement de la physique, et pour son leadership à promouvoir l'adoption de stratégies d'enseignement innovatrices fondées sur la recherche dans la collectivité canadienne de l'enseignement de la physique.

Interview with Martin Williams, July 2017 (by Daria Ahrensmeier)

Daria: Congratulations on your teaching medal.

Martin: Thank you very much.

Recipient of the 2017 Medal / Lauréat de la médaille 2017:

Martin Williams

Daria: In a few words, can you describe your teaching accomplishments?

Martin: I think the citation says I was awarded this medal for my work in curriculum development, for my passion for teaching, and for my perceived ability to teach and actively engage really large classes. I have been trying to develop a different model for teaching large classes, which is significantly different to teaching smaller classes. I've tried to come up with a way that works for large classes, because not many people have experience with this and not many institutions have it. The worst thing that you could possibly do is to try to teach a large class the way that you teach 50 or 75 students. You have to come up with a completely different model. So, that is something that I

worked on over a number of years and I think that I must be getting success to some extent, because students seem to really appreciate it.

Daria: What is this model you developed for large classes?

Martin: The model is not a rigid, strict "step 1, step 2, step 3". The use of technology is important, because obviously, in a large classroom, you don't have the luxury of that personal interaction that you have with students in smaller classes—you don't know the names. For example, in all of our large classes, you must use some engagement technology such as iClickers or something along those lines. It's the least that you can do to let students feel that they are part of the class.

"I am extremely honoured to receive this award. I must acknowledge, however, the immense pleasure and fulfilment I already derive just from being in the classroom in my current role. This award thus recognizes the stellar support of my department and peers at Guelph, the suffering of countless students and the enduring patience of my family"

The other thing about teaching large classes, I think, is to recognize that it is not possible to engage with all these students through office hours. Thus the role of TAs becomes really crucial, and developing a TA system effective in terms of training is an essential part of that system.

Developing the assessment mechanisms for large classes is really important. We do not do the typical midterms and that sort of stuff. Instead we moved to a mastery approach model where students take five quizzes in a semester (a quiz every three or four weeks) to prove mastery of each concept. Each quiz is worth 10 per cent of their final grade and they have up to three attempts at each quiz to demonstrate that they've mastered the concept covered by that quiz. A score of 80% is required to show mastery. This can either be obtained in a single attempt at the quiz, or can be a cumulative score. Thus, by using this method, students have an opportunity to achieve mastery throughout the span of the three attempts.

But the best part of that system is the students get instant feedback. They walk in, they try to do the quiz and, immediately after writing the quiz, they sit down with the TA who walks them through the quiz, marks it, assesses the quiz right in front of them, and gives them feedback. The students walk away from the quiz saying, "OK, I need to go back and figure out how to do these conservation of energy problems, because that's where my issue is." It's a diagnostic tool that gives each student feedback as a way to strengthen weaknesses. The students can go back, look at that stuff, and come back and try the quiz again. Where we started initially, we'd say no deadline, but what happened is that students procrastinated; they tried to do all five quizzes, which are worth 50 per cent of their grades, in the last two weeks. So, after a while, we introduced boundaries by saying, "The first quiz must be finished by week 2; the second quiz, you must finish it by week four — or whatever it is. However, if you feel that you understand a concept, you can take the quiz any time before the deadline, so you don't have to wait. This way you can learn at your own pace." This is something that is unique to our large classes.

How we teach, how we assess those large classes, is not a perfect system, but the student feedback is really quite interesting — our students have over the years said that their best first-year experience is physics. At least science students.

« Je suis fort honoré de recevoir ce prix. Je dois toutefois reconnaître le plaisir immense et la satisfaction que donne le simple fait de jouer mon rôle actuel en classe. Ce prix témoigne donc du solide soutien de mon département et de mes pairs à Guelph, de la souffrance d'innombrables étudiants et de la patience sans bornes de ma famille. »

Daria: Now, tell us a little bit about your background and your training, where you're coming from. When did you decide to go into physics and why, and what kind of physics was interesting for you?

Martin: Yes, that's interesting, but a bit of a long story. Coming through high school, I distinctly remember that physics just made sense to me. I never thought that I was good at physics, but I thought that it made sense to everyone. When I was in grade 11, grade 12, I remember my physics teacher — who was not one for giving praise easily — said to me, "Williams, you know, you're actually good. You should think about doing physics at university." I said, "Really?"

So, I went to university to do physics, because I figured … if my teacher thinks that I'm good at this stuff then I should pursue it. But as I said, I never had this big, massive dream that "This is what I want to do, I want to become a physicist." It just evolved naturally. So, I went to university and I did physics and when I finished my first degree, they said to me, "We think you're actually good at this stuff. We'll put you up for a scholarship, if it's something you might be interested in." I said, "Sure." So, I went to grad school and took physics, and after grad school, I figured that I probably should teach, I should become a faculty member, because by then I was really passionate about physics, I really recognized that — especially the solid-state physics or modern physics, that was my thing. I did most of my research on quantum hall effect and fractional quantum hall effect. And one of my claims to fame is the guy who got a Nobel Prize for the quantum hall effect had his lab next to mine.

So I had it all planned. I just was going to do my research on solid-state physics, and just do the things that a faculty member would normally do. But what was really interesting is that I hated teaching when I started as a junior faculty member. I hated teaching with a passion simply for the reason that I knew nothing about teaching and I invested a lot of time in preparation for my lectures. I remember those first years, I'd spend two, three hours preparing every lecture and walk into the lecture and students would be completely oblivious, they

would be chatting and doing everything else but paying attention. And that was so discouraging and disheartening, after I'd put three hours into a lecture. I'd be there saying, "This is amazing," and they'd look at me as if I was from a different planet or whatever. That rejection really turned me off from teaching. So, for a number of years, I just wanted to do my research and I just showed up in the classroom.

I think what really sort of eventually piqued my imagination was that I heard students who had taken a course with me, and in a subsequent semester had taken a physics course with another professor, chatting in the corridors saying, "This guy's amazing," speaking about another colleague. And I would think to myself, "That is an interesting statement." So, it's not that these students hate physics, it's me. I must really suck at this stuff. [Chuckles] And that was the start of an interesting experience.

So, I started to attend classes of my colleagues, all of these professors that I knew students marveled at. I started sneaking in the back of their classes just to see what it is they're doing in their class that I was not doing. I started chatting with them afterwards and I would ask, "How did you do that?". One colleague told me "There are simple rules to keep in mind such as students' attention spans and making sure you have planned your lectures. Make sure you always have them in the first 10 to 15 minutes. But when you get to the 15 minutes, as soon as you see their heads start to look down or whatever it is, you know you're losing them. It's an important point when you need to transition to something else. Whatever it is that you want to use to keep your students engaged."

I started sneaking in the back of the classes of my colleagues that students marveled at, just to see what it is they're doing in their class that I was not doing, and I started chatting with them.

That was my transition into teaching. I started implementing these little things and the change in my class was noticeable. I was completely hooked knowing that I can have that sort of impact on students, if I kept these simple rules. The rest is history. I think I became addicted to this thing after a while. And it's funny, if anyone had said to me that I'd be caring so much about teaching, 15, 20 years ago, I would have said, "You're out of your mind, you must be smoking something." I had no interest in teaching. And now… when I go the classroom, it's not a job. It's something that I'm tremendously passionate about. Even if I'm not having a good day, the moment I walk into that space, it's a completely different experience for me. I think people have jobs and people have careers and very few people get to do something that they're passionate about and like in life. So, to me, I think it's an absolute blessing just to be able to do and to be paid to do the stuff that I really like.

Daria: That's a beautiful sentiment. Now let's go further back into your life. Where did you go to high school?

Martin: My parents are from South America, what used to be British Guiana, a small British colony. That's where I did my early stuff. And then, I went to England for my graduate studies.

Daria: Which university did you attend in England?

Martin: Imperial College.

Daria: When you compare different countries where you've lived, received an education, or taught in, what stands out to you?

Martin: I was lectured to in the British system. I was never taught, I was lectured to. And there's a fundamental difference. In a lecture, the expectation is that there's no way that the lecturer would ever cover everything, so you're provided with the basic sort of skeleton, and you are meant to flesh out all the bits. So, there was never a course textbook, there were multiple textbooks. You read them, and you found something that resonated with you and you understood. So, there were always multiple textbooks that were prescribed. When I came into the system here where there is a course with only one textbook, it made no sense to me, because when I read three books, three different explanations, by the time I had done that, I had gotten a fairly good understanding. So, sticking to one book never really made a lot of sense to me. But so, there are always pros and cons in a system.

Daria: Do you have a favourite topic that you particularly like to teach?

Martin: Modern physics, absolutely. I love to teach modern physics. One of my favourite courses used to be a second-year course we had called "The Experimental Basis of Modern Physics." It's not just the dry history, but it was developed to understand the thinking behind the concepts and how they evolved – these ideas that we just take for granted and just write on the board. Those experiments, that bit of modern physics, I've always found fascinating and I love to teach the whole — from about the 1890s right up to 1950. That's my favourite bit of physics.

Daria: Do you still do research in physics?

Martin: Oh, yes, we have to. At Guelph, we have a distribution of effort. So, traditionally, it's 40, 40, 20 for teaching, research and service. I do 60, 20, 20. I can choose to do more research and I can choose to do traditional research or physics education research. There's an implicit agreement that I would do physics education research because it's important for the department that I can feed that information back to my colleagues.

Daria: Does this mean that your education research is recognized as research?

Martin: Yes, and that's really important. I'm required to publish like anyone else, and if you write books, that is scholarship.

Daria: Is your research focused on the topic of large classes?

Martin: We've published some work on gamifications, so we were working on gamification for quite a while with my last graduate student. At the moment, my current grad student is working on labs. Before that, we did quite a lot of work on clickers and active engagement. We looked at what really occurs during peer instruction, whether it's peer instruction or peer pressure. So, what we tend to find is that if a third of my class understands a concept, they are much more efficient at transferring that information to their colleagues than I am, because they are familiar with their friends and can explain it in a way that's much more effective and efficient than I can.

The CAP Congress is the only conference for physics education research in Canada. It has been a pivotal and invaluable part of my growth and development as a teacher.

And then, I remember working with Ernie McFarland about the placement of questions in multiple choice exams and how it influences the results. We knew it had an effect. If you put a lot of easy questions right at the start of the multiple choice exam, students build confidence and feel that they can actually do this stuff. If you put really challenging questions right at the front of the exam, it psychologically affects students. So, we planted certain sets of questions at certain places. Some of the easy questions were at the front for some students and so we could see the students who had easy questions in front did better. But we couldn't find it to be statistically significant. But yes, that was one where we were disappointed.

Daria: Do you see any effect of the current funding situation on teaching in universities?

Martin: Oh, absolutely. Universities have tried to deal with a shortfall in funding by building bigger classrooms, which means that we ended up teaching classes of 600 students. No one can convince me that it's the same experience for students in the classroom with 60 students versus 600 students. If I had to choose, I would always choose to be in the 60. And so, that's the first direct impact, I think. The second impact that we dislike is the fact physics classes are not always held in the physics building.

Decisions about where classes are held are not based on the pedagogy, but based simply on space requirements. So, you're put into a room not because this is the best pedagogical experience for the students to have, but simply because universities have challenges with some space. All of our demonstration labs are next-door to the classrooms in our physics building, so we could literally wheel our demonstrations into the physics labs. But now we are sometimes taken out of the physics building and sent across different parts of campus and so lose access to those demonstrations.

Daria: If you had unlimited funds, what would you do about teaching?

Martin: For one, absolutely, there'd be smaller classes. I'd cap the class sizes to probably at most, at max, 100 students. For my TA budget, I'd double my TA budget because I think that — especially in a large group or large labs, students complain that they do not have enough attention from TAs and that frustrates them. So, I'd absolutely double my TA budget. And I think that would significantly enhance the learning experience for students. And of course, if possible, we'd hire more faculty. Another sort of fallout from funding cuts is that they have increased the number of courses that we have to teach in a year. So, typically a faculty member, at 40 per cent, taught two courses. Now, it's three. What that does, obviously, if you teach more, it affects research and the quality of teaching.

Daria: What's the value of the CAP and the CAP Congress for a teacher? What role does the CAP play for someone who's teaching in general?

Martin: I think that for a long while, I was completely oblivious to the lobbying role that the CAP plays and I think a lot of people are not familiar with the fact that they make budget submissions and they'll have meetings with the ministers and the MPs all through the year. So, the policy aspect in terms of representing all physicists across Canada, is really important and vital.

Of course, most people think of the CAP in terms of the CAP Congress and that is important because being associated with the Congress for more than 10 years has been a pivotal part of my growth and development as a teacher and invaluable. I've met so many people who have taught me so many things, so many good conversations in the corridors and networking and it has had the most significant impact in terms of what I've learnt about teaching. No one has really taught us about how to teach. And so, going to these presentations and talking to people, it has been absolutely invaluable, and just sharing with my colleagues, sharing in terms of sufferings and pains and challenges, and figuring out ways how to do things.

So, the CAP, for the area of physics education, it's the only place that I can go to meet colleagues in Canada. It's the only conference for physics education research in Canada. It is absolutely crucial for what I do and I don't think I've missed the CAP Congress for the last 12 or 13 years.

Daria: Thank you so much.

Martin: Not at all. Good luck to you!

CAP/DCMMP Brockhouse Medal
La Médaille Brockhouse de l'ACP/DPMCM

Yong Baek Kim is a renowned condensed matter theorist whose research has had significant impact on our understanding of the physics of geometrically frustrated and highly correlated quantum materials. He has been working at the leading edge of the effects of large spin-orbit coupling on exotic ground states in materials, especially those arising from frustration and Mott physics. This has naturally focused on the very topical area of iridate physics, and there is no doubt that Yong Baek has been a key international figure in this field. He has produced a significant and well-cited body of work on iridate quantum magnetism in the presence of Kitaev and Kitaev-like interactions. This general theme – the role of spin orbit coupling in correlated electron physics – is one that has only just begun to be explored both theoretically and experimentally. However, the field possesses a large scope for interesting new exotic ground states due to 4d and 5d transition metal complexes, which are much less studied, at present, than their 3d counterparts.

The 2017 CAP/DCMMP Brockhouse Medal is awarded to Dr. Yong Baek Kim, University of Toronto for his leading work on the effects of large spin-orbit coupling on exotic ground states in geometrically frustrated and highly correlated quantum materials.

Yong-Baek's theoretical efforts have been guiding and providing a framework through which this experimental work can be rationalized. It is easy to foresee that his work will become even more influential in the immediate future. Yong Baek Kim's body of work on spin orbit coupling, topological phases of matter and geometrical frustration is both highly original and proven to be influential to a large body of condensed matter physics research.

La Médaille Brockhouse de l'ACP/DPMCM 2017 est décernée à Yong Baek Kim, Université de Toronto, pour ses travaux de chef de file concernant les effets de l'ample couplage Russell-Saunders (spin-orbit coupling) sur les états fondamentaux exotiques dans les matériaux quantiques géométriquement frustrés et fortement corrélés.

Finally, he has played a key leadership role on the international scene of quantum materials research as a co-organizer of many workshops and conferences related to geometrical frustration and topological properties of high correlated materials. He is unquestionably highly deserving of the CAP Brockhouse Medal.

Remarks by Yong Baek Kim

I feel very honoured to be recognized by the 2017 Brockhouse Medal. I would like to share this honour with my students and postdoctoral fellows as well as collaborators who have been involved in the research program on quantum materials with strong spin-orbit coupling. This has been an emerging area of research and as such it required a great deal of faith in the initial research program that I was proposing and pursuing. In this context, I would like to particularly thank my students for their trust in my research program. I would also like to thank the members of the Quantum Materials program in the Canadian Institute for Advanced Research and other colleagues in the canadian condensed matter physics community, for numerous scientific discussions and generously sharing their knowledge and resources. Without such support, this research program would not have been successful.

"I feel very honoured to be recognized by the 2017 Brockhouse Medal. This award certainly reflects the contributions of talented students, postdoctoral fellows, and collaborators from whom I have learned a great deal of physics. I am also very grateful to numerous colleagues for generously sharing their knowledge and resource."

« Je me sens très honoré d'être reconnu par la Médaille Brockhouse 2017. Ce prix témoigne à coup sûr des apports d'étudiants talentueux, de boursiers postdoctoraux et de mes collaborateurs de qui j'ai beaucoup appris en physique. Je suis en outre reconnaissant à de nombreux collègues d'avoir partagé généreusement leur savoir et leurs ressources. »

Recipient of the 2017 Medal / Lauréat de la médaille 2017:

Yong Baek Kim

CAP Herzberg Medal

La Médaille Herzberg de l'ACP

Paul François is one of the world's leading experts in theoretical biophysics, in particular for the modeling of cellular behavior using tools from nonlinear, statistical and computational physics. In particular, François used Monte Carlo approaches to study directed evolution of nonlinear systems modelling gene networks, which led to several theoretical advances in the description of evolution and of systems ranging from immune recognition, biological nonlinear oscillators to vertebrate development. He is using phenomenological approaches inspired by physics to develop "phenotypic models", for instance explaining theoretically many contradictory experimental aspects of early immune recognition. In addition he has applied physical insights to the study of embryonic development. He has developed analysis tools to quantify embryonic development, model flows and diffusion of cells in embryonic tissue. More recently he has built oscillatory phase models explaining puzzling properties of development such as scaling of vertebrae with embryo size or coupling of multiple oscillators driving vertebrae formation. He has been collaborating with several international groups in quantitative immunology and embryonic development, to whom he has provided unique theoretical support. Prof. François' work has been published and featured in the most prestigious interdisciplinary science journals and his work has been recognized by major awards including a 2014 Simons Investigator award for mathematical modelling of biological systems.

The 2017 CAP Herzberg Medal is awarded to Dr. Paul François, McGill University for his seminal research in theoretical biophysics, particularly the use of methods from statistical and computational physics to model cellular processes as non-linear dynamical systems.

La Médaille Herzberg de l'ACP 2017 est décernée à Paul François, Université McGill, pour son travail de pionnier en recherche biophysique théorique, notamment dans l'application de méthodes de physique statistique et computationnelle à des modèles de processus cellulaires, tels les systèmes dynamiques non linéaires.

Remarks by Paul François

It is a tremendous honour to receive the CAP Herzberg medal. I would like to first and foremost thank the Canadian Association of Physicists. It is wonderful to see recognition for theoretical biophysical approaches.

"I am humbled and honored to receive the CAP Herzberg medal. I have been very lucky to work with tremendous students, postdocs and collaborators, and it is wonderful to see recognition for our biophysical approach."

There is still much to understand on how physical principles drive the « living matter ». I find amazing how physics sheds light on complex biological systems. As a theorist, I am convinced that we will discover more and more fundamental principles in biology very similar to what we already know in physics. Theoretical biophysicists already had a crucial role in the development of some of the most important biological ideas. I would say modern biophysics was born a bit less than one century ago, with the so-called "Quantum" model of gene proposed by Dellbruck. This was the basis of the aperiodic crystal model for genetic information discussed by Schrodinger in his famous book "What is life ?" in the 40s, that inspired the theoretical model of Watson and Crick. Another theoretical contribution I admire is the kinetic proofreading model by John Hopfield and Jacques Ninio, who essentially understood and quantified how biochemical processes such as DNA replication could "beat" thermodynamics with the help of energy injection. Such contributions had major impacts on our physical thinking of the cell, and modern biophysical tools allow now to observe such processes with great details, confirming those theoretical ideas, and allowing for the discovery and elaboration of other new principles. We are

« Je suis très honoré et très touché de recevoir la Médaille Herzberg de l'ACP. J'ai eu la grande chance de travailler avec des étudiants, post-docs et collaborateurs exceptionnels, et c'est extraordinaire de voir notre approche biophysique reconnue. »

Recipient of the 2017 Medal / Lauréat de la médaille 2017:

Paul François

entering a golden age for physics applied to biology, with massive amount of data and much better external control of the cell considered as an out of equilibrium dynamical systems. As a professor, I show students how exciting and open this field is, and as a researcher, I am doing my best to build similar physical thinking on a variety of biological problems.

All of this requires interdisciplinary expertise and broad collaborative approaches. I have been very lucky to work with astounding experimental collaborators. With Olivier Pourquié (Harvard), Sharon Amacher (Ohio State), and Alexander Aulehla (EMBL), we have uncovered many fascinating aspects of non linear oscillators implicated in embryonic development. Grégoire Altan-Bonnet (NIH) brought me into the theory of immunology, which is beautifully connected to problems ranging from statistical mechanics to machine learning. I am also grateful to all my colleagues, students and post-docs, and I have very much enjoyed and benefited from the recent boom of biophysics within the McGill/Montreal environment. I am also very grateful to my three scientific mentors. Kirone Mallick, at CEA Saclay first introduced me to the joy and excitement of research, and to fascinating topics in out of equilibrium statistical mechanics very relevant for living systems. Vincent Hakim, my PhD supervisor at Ecole Normale Supérieure in Paris, taught me how non linear physics and computational Monte Carlo methods could be applied to biology. Eric Siggia, my post doc supervisor at Rockefeller University in New York, turned me into a real scientist able to bridge physics into biology. I am trying my best to provide to my own trainees guidance and support similar to what I have received myself.

Finally, I would like to thank my best friend and colleague, Audrey Moores, my wife, for her constant love and support.

CAP Medal for Lifetime Achievement in Physics

La Médaille de l'ACP pour contributions exceptionnelles à la physique

Mark Sutton is an internationally renowned experimentalist in condensed-matter physics. Sutton uses X-ray diffraction to study the behaviour of non-equilibrium condensed-matter systems. He has developed and applied, together with his colleagues, an important new X-ray technique called X-ray Photon Correlation Spectroscopy (XPCS), which makes use of the X-ray equivalent of optical speckle. This new probe directly measures the time evolution of equilibrium and non-equilibrium microstructures at length scales down to a nanometer with millisecond time resolution. The first demonstration of the use of coherent X-rays for XPCS was reported by Sutton et al. in Nature in 1991. This breakthrough paper has generated a very successful series of trend-setting papers and reviews.

The 2017 CAP Medal for Lifetime Achievement in Physics is awarded to Dr. Mark Sutton, McGill University, for pioneering the development of coherent and time-resolved X-ray scattering techniques for the study of materials, and his resulting contributions to our understanding of materials and phase transitions.

La Médaille de l'ACP pour contributions exceptionnelles à la physique 2017 est décernée à Mark Sutton, Université McGill, pour ses travaux en conception de techniques cohérentes de diffusion des rayons X à résolution temporelle destinées à l'étude des matériaux, et pour l'apport qui en découle à notre compréhension des matériaux et des changements de phases.

Recipient of the 2017 Medal / Lauréat de la médaille 2017:

Mark Sutton

The method was further developed by Professor Sutton and his collaborators to investigate important problems in condensed-matter physics involving phase transitions and complex fluids. For example, in his recent

studies, last on AuAgZn2, where he determined its order-disorder critical temperature he directly observed critical fluctuations and critical slowing down. Sutton has also applied XPCS to polymer systems, measuring wave vector-dependent time constants in these technologically-important materials. Sutton has used XPCS to show that domain coarsening involves persistent large-scale fluctuations during phase separation during spinodal decomposition and order-disorder transitions. To put this achievement into context, it is probably the most significant experimental work on first-order phase transition kinetics in the last decade.

Sutton's research has always had two equally important main areas of development. The first is to develop better instrumentation and techniques for in-situ time-resolved x-ray scattering to help address his research interests in basic science. He has been involved in designing and building instrumentation at the world brightest x-ray synchrotron sources and the new x-ray laser at SLAC. The second focus is to understand the underlying physics by performing experiments on materials where microstructure plays an important role.

Remarks by Mark Sutton

First, I would like to thank the CAP for the surprise and honour of being awarded the Lifetime Achievement Medal for Physics. I have always said that I have been fortunate in my career to be able to work at my hobby and to be paid for doing it. Being recognized on top of this is the icing on the cake.

"I am honoured and delighted for the recognition of my work by the CAP. I wish to thank my many collaborators, students and postdocs over the years, not only were they fun to work with, I learned a lot from them."

During my career, I have been fortunate at many levels. First, for the guidance of my PhD supervisor, Prof. Robin Armstrong, his insights and guidance still influence me in how I think about and do research. My post-doc supervisor Prof. R.J. Birgeneau, whose knowledge and passion for physics have also provided much guidance. I have been fortunate to have two long-time collaborators and friends whom I would like to mention, Dr. Brian Stephenson and Prof. Martin Grant. In addition, there are my many graduate students, postdocs and other collaborators with whom I have worked over the course of my « lifetime achievement ». Over the years, I have been able to pursue my hobby with them; not only were they fun to work with, but I have learned a lot from them as well.

I have also been fortunate to have been in the right place at the right time. My research uses x-rays to probe the structure and properties of materials and my career has spanned a revolution in x-ray scattering. I have been part of designing and building of x-ray diffraction beamlines at the beginnings of the National Synchrotron Light Source at Brookhaven in the early 1980s, the Advanced Photon Source at Argonne in the 1990s, the Linac Coherent Light Source at Stanford in the 2000s and again at the National Synchrotron Light Source II in Brookhaven in the 2010s. Research is generally easy when you have the best tools to work with. It is my opinion that one of the largest impacts that physics has had on society has been to develop the instrumentation and tools used by the many branches of science. Besides, with new instrumentation, one can look at nature and, simply by observing, see and discover new things.

« Je suis honoré et ravi de la reconnaissance de mon travail par l'ACP. Je tiens à remercier mes nombreux collaborateurs, étudiants et boursiers postdoctoraux avec qui il a été non seulement agréable de travailler mais de qui j'ai beaucoup appris au fil des ans. »

As it turns out, with my research centered at labs around the world, I have been a «suitcase physicist». The Physics Department at McGill has been very supportive of this and I am grateful, as the research could not have been done otherwise.

Finally, needless to say, I thank my wife and my two daughters who have put up with this nonsense and made life most enjoyable.

High School / CEGEP Physics Teaching Awards / *Prix ACP en enseignement de la physique au secondaire et au collégial*

2017 Winners / Récipiendaires 2017

Prairies and Northwest Territories / Prairies et Territoires du Nord-Ouest

Karen Kennedy-Allin
Weyburn Comprehensive School
Weyburn, SK

Karen Kennedy-Allin is a dynamic, student-centered teacher, who always tries to inspire her students with her enthusiasm and passion for Physics. Whether it is with hands on marshmallow launchers and rollercoaster projects, or mind-blowing modern Physics, her students remain engaged and active in their learning process.

Karen believes very strongly in sharing her knowledge and enthusiasm with other teachers, as others have done for her. Since she first attended the Perimeter Institute for Theoretical Physics in 2008 she has facilitated workshops in both Saskatchewan and Manitoba showcasing the modern physics resources she learned about. She has also mentored teachers within her school division by providing outlines, unit and lesson plans for Physics 30, as well as working in groups to develop resources.

As one of four teachers chosen to write the new Physics 30 curriculum for the province of Saskatchewan, Karen has worked with the Ministry of Learning for the past three years. Over the course of this time, Physics 30 has transformed from mostly classical physics to a more balanced approach between modern and classical. She went into the curriculum process with a strong belief that students needed to be made aware of the cutting edge of Physics and that since there is so much left to be studied, it is a worthwhile career consideration for high school students. Karen will be a part of the new curriculum implementation this fall and will continue to work with as many teachers as possible.

Karen Kennedy-Allin est une enseignante dynamique, centrée sur ses étudiants, qui essaie toujours de les inspirer par son enthousiasme et sa passion pour la physique. Qu'il s'agisse de projets pratiques de lanceurs de guimauves et de montagnes russes ou d'une physique moderne époustouflante, ces projets maintiennent les étudiants engagés et actifs dans leur processus d'apprentissage.

Karen croit fermement au partage de son savoir et de son enthousiasme avec les autres professeurs, comme d'autres l'ont fait pour elle. Depuis sa première présence à l'Institut Périmètre de physique théorique en 2008, elle a animé des ateliers illustrant les ressources modernes de la physique qu'elle a connues, en Saskatchewan et au Manitoba. Elle a aussi joué un rôle de mentor auprès de professeurs de sa division scolaire en fournissant des aperçus, des unités et des plans de cours de Physique 30, et en œuvrant dans des groupes à concevoir des ressources.

Karen est l'une des quatre professeurs choisis pour élaborer le nouveau programme Physique 30 pour la province de la Saskatchewan. À ce titre, elle travaille au ministère de l'Apprentissage depuis trois ans. Durant cette période, ce programme, surtout classique, a adopté une formule plus équilibrée entre le moderne et le classique. Karen est passée au processus des programmes en croyant fermement que les étudiants doivent connaître la fine pointe de la physique et que, puisqu'il leur en reste tellement à apprendre, c'est une carrière qu'il vaut la peine d'envisager pour les étudiants du secondaire. Karen participera à la mise en œuvre des nouveaux programmes à l'automne et continuera à travailler avec le plus grand nombre possible de professeurs.

Ontario

Lisa Cole
Durham District School Board
Whitby, ON

Lisa Lim-Cole is a one-of-a-kind physics educator. Her creative approach inspires students to explore everyday experiences and deepen their conceptual understanding.

Lisa illuminates for physics students the relevance of their learning and connects physics to career pathways. This has increased physics enrollment at her school and inspired many students to pursue degrees in physical science and engineering. Currently, Lisa has a central role supporting K-12 STEM educators in the Durham District School Board (DDSB). Lisa created the DDSB STEM Plan and works with DDSB educators to develop innovative strategies for physics-STEM teaching and learning. Lisa continues to explore new ways to promote physics-STEM by annually organizing student events like STEM

Olympics and Mystery Box Challenges, and by mentoring groups of students in events like Future City Competitions, Inspiring Girls in STEM and STEM Talks.

Her love for physics, students, and lifelong learning drive Lisa to engage in conversations throughout Ontario with peers, students, parents, and top-level civil servants. Her goal is to advocate for and support physics / STEM education. Lisa is past president of the Ontario Association of Physics Teachers and is the Eastern Ontario Teacher Network Coordinator for the Perimeter Institute for Theoretical Physics. She has organized provincial physics teachers' conferences and participates in the national Engineering Change Lab. Lisa believes that addressing diversity in physics/STEM starts with inspiring physics / STEM educators to learn alongside their students.

Lisa Lim-Cole is a dedicated physics educator who motivates large numbers of students and teachers and inspires creativity and innovation in physics and STEM education.

Lisa Lim-Cole est une enseignante en physique unique en son genre. Son approche créatrice incite les étudiants à explorer leurs expériences quotidiennes et approfondit leur compréhension conceptuelle.

Aux étudiants en physique, Lisa révèle la pertinence de leur apprentissage et relie la physique à des choix de carrière. Cela a relevé les taux d'inscription en physique à son école et incité nombre d'étudiants à acquérir des diplômes en sciences physiques et en ingénierie. Actuellement, Lisa joue un rôle central à l'appui des enseignants de STIM de la maternelle à la 12e année de la Durham District School Board (DDSB). Elle a créé le plan des STIM de la DDSB et travaille avec les enseignants de la DDSB à élaborer des stratégies novatrices pour l'enseignement et l'apprentissage des STIM. Lisa continue d'explorer de nouveaux moyens de promouvoir la physique-STIM en organisant chaque année des activités étudiantes tels les olympiades STIM et les défis de la boîte mystère (Mystery Box Challenges), et en se faisant le mentor de groupes d'étudiants lors d'activités comme les Concours Ville du futur (Future City Competitions), l'incitation des filles vers les STIM et les entretiens sur les STIM.

Son amour de la physique et des étudiants et de l'apprentissage permanent pousse Lisa à nouer des conversations dans tout l'Ontario avec ses pairs, des étudiants, des parents et des fonctionnaires de rang supérieur. Son objectif est de promouvoir et soutenir l'enseignement de la physique / STIM. Lisa est une ancienne présidente de l'Ontario Association of Physics Teachers et coordonnatrice de l'Eastern Ontario Teacher Network pour l'Institut Périmètre de physique théorique. Elle a organisé des conférences provinciales de professeurs de physique et participe au Laboratoire national des changements (génie). Lisa croit que, pour réaliser la diversité en physique/STIM, il faut d'abord inciter les enseignants de cette discipline à apprendre aux côtés de leurs étudiants.

Lisa Lim-Cole est une enseignante dévouée en physique qui motive un grand nombre d'étudiants et professeurs et inspire la créativité et l'innovation dans l'enseignement de la physique et des STIM.

Quebec and Nunavut / Québec et Nunavut

Luc Tremblay
Collège Mérici
Québec, Qc

Luc Tremblay, who has been teaching physics since 1994, won the Honourable Mention of the Association québécoise de pédagogie collégiale in 2011 and the Award of the Minister of Higher Education, Research and Science in 2014. The course notes that he posted online are read all around the world and are used in other educational institutions, including universities. With his hybrid approach made of traditional methods and conceptual issues, Mr. Tremblay has also introduced a problem-centered approach in a science integration course. He has also been the coordinator of the natural sciences program for nine years and participated twice, as an expert, to the work of the Commission d'évaluation de l'enseignement collégial. He is also involved in his college students' life, in sport activities like cosom hockey, in cultural activities such as the improvisation league or in scientific activities like the guidance of students in science competitions, the chess club or the demonstration of the law of gravity with pumpkins at Halloween. Luc Tremblay won the Award for Excellence in Teaching High School/CEGEP Physics for all these reasons.

Enseignant en physique depuis 1994, Luc Tremblay a remporté la Mention d'honneur de l'Association québécoise de pédagogie collégiale en 2011 et le Prix du ministre de l'Enseignement supérieur, de la recherche et de la science en 2014. Les notes de cours qu'il a mises en ligne sont lues partout dans le monde et sont utilisées dans quelques autres établissements d'enseignement, notamment des universités. Utilisant une approche hybride de méthode traditionnelle et de question conceptuelle, M. Tremblay a aussi implanté une approche par problèmes dans un cours d'intégration des sciences. Il a également été coordonnateur du programme de Sciences de la nature pendant neuf ans et a participé à deux reprises, à titre d'expert, aux travaux de la Commission d'évaluation de l'enseignement collégial. Il s'implique également dans la vie étudiante de son collège, que ce soit pour des activités sportives, telles que le hockey cosom, des activités culturelles, telles que la ligue d'improvisation ou des activités scientifiques, telles que

l'encadrement des étudiants pour les concours scientifiques, le club d'échecs ou la démonstration de la loi de la chute des corps avec des citrouilles à l'Halloween. C'est pour l'ensemble de ces raisons que le Prix d'excellence en enseignement de la physique au secondaire et au collégial est décerné à Luc Tremblay.

Atlantic / Atlantique

Kevin Farrell
Cobequid Educational Centre
Truro, NS

Kevin Farrell has been a physics teacher at Cobequid Educational Centre (CEC) since 1993. Kevin has been an active member of the Association of Science Teachers in Nova Scotia for many years. He has provided professional development to hundreds of teachers during his career with sessions ranging from providing ideas for teaching physics concepts in grades 3-6 to elementary teachers to leading round table discussions on the IB Physics curriculum.

Kevin can make the most complicated concepts make sense and he does so through the use humour and innovative sample problems. According to his students, Kevin makes physics dynamic, creates labs that capture and keep their attention, and provides students with challenging problems all while maintaining a sense of lightness in class that leads to intense learning. Kevin's IB Higher Level Physics students consistently finish well above the world average and they often fill many of the top spots in Nova Scotia on the CAP High School Exam.

Kevin is regarded as a mentor, friend and contributing member of CEC's faculty. He is — say his colleagues — the most involved staff member at CEC. He attends almost every sporting event, play and concert and he has been a chaperone on many school trips to Europe. All of this activity outside the classroom allows him to build rapport with students in his class. Kevin's obvious interest in students' extracurricular activities helps them feel connected to him, resulting in deep feelings of respect that flow both ways.

Kevin resides in Truro, Nova Scotia. He is married to Maureen and has two children, Kevin and Lauren, both of whom he is currently teaching. He was a 2014 recipient of an Excellence in Teaching Award from the Chignecto Central Regional School Board.

Kevin Farrell, qui enseigne la physique au Cobequid Educational Centre (CEC) depuis 1993, est membre actif de l'Association des professeurs de sciences de la Nouvelle-Écosse depuis bien des années. Il a assuré le perfectionnement professionnel de centaines d'enseignants au fil de sa carrière par des séances allant de l'apport d'idées pour l'enseignement de notions de physique aux enseignants d'élèves de la 3e à la 6e année, à l'animation de tables rondes sur le programme Physique IB.

Kevin peut donner un sens aux concepts les plus complexes, et cela, en recourant à l'humour et à des exemples de problèmes novateurs. Selon ses étudiants, Kevin rend la physique dynamique et crée des laboratoires qui captent et retiennent leur attention. De plus, il apporte aux étudiants des problèmes de taille tout en conservant en classe une atmosphère de légèreté qui permet un apprentissage intense. Les étudiants de Kevin en Physique IB de niveau supérieur dépassent sans cesse largement la moyenne mondiale et occupent souvent des rangs de haut niveau en Nouvelle-Écosse à l'Examen de l'ACP au secondaire.

Kevin est considéré comme un mentor, ami et membre précieux du corps professoral du CEC, dont il est le membre le plus engagé, de l'avis de ses collègues. Il est de presque toutes les activités sportives et assiste à tous les matchs et concerts et il a accompagné bien des voyages de son école en Europe. Toute son activité extérieure à la classe permet à Kevin de nouer des liens avec ses étudiants. Son intérêt marqué pour leurs activités parascolaires les aide à se sentir reliés à lui, ce qui suscite de vifs sentiments de respect mutuel.

Kevin habite à Truro, en Nouvelle-Écosse. Époux de Maureen, il a deux enfants, Kevin et Lauren, tous deux ses élèves. En 2014, la Central Regional School Board de Chignecto lui a décerné un prix d'excellence en enseignement.

Lisa Cole was selected to receive the 2017 Perimeter Institute Physics Education Scholarship which includes travel support (provided by Perimeter Institute, the CAP, and the Institute for Particle Physics) to attend a special three-week international workshop for high school teachers hosted by CERN, the world's premier particle physics laboratory located in Geneva and an opportunity to attend the 2018 Perimeter's Einstein Plus camp. Lisa Cole's report on the 2017 workshop is included in this issue of PiC. The remaining winners were offered the opportunity to participate in a one-week research experience at TRIUMF, SNOLAB or CLS.

Lisa Cole s'est vu décerner la bourse 2017 de l'Institut Perimètre en enseignement de la physique, comprenant une aide aux déplacements (fournie par l'Institut Perimètre, l'ACP et l'Institut de physique de particules) pour assister à un atelier international spécial de trois semaines pour enseignants au secondaire donné par le CERN, premier laboratoire du monde en physique de particules situé à Genève, et permettant de prendre part au Programme « Einstein Plus » 2018. Les autres lauréats se sont vu offrir l'occasion de participer à une expérience de recherche à TRIUMF, SNOLAB ou au CCRS.

Adventures @CERN with High School Physics Teachers from around the World

by Lisa Cole

2017 High School Teacher Program Participants

July 2017 will forever be a fond memory! As a result of winning the Ontario Excellence in High School/CEGEP Physics Teaching Award by the Canadian Association of Physicists, I attended the High School Physics Teacher Program @CERN as the Canadian teacher participant! Thank you, Canadian Association of Physicists and Perimeter Institute for Theoretical Physics for providing this once-in-a-lifetime experience! The CERN High School Teacher program involved 43 Teachers from 34 countries gathered together to network, learn and experience the amazing facilities at CERN. The three week program was action packed with lectures, facility tours, workgroup sessions and lots of discussions. Jeff Wiener and Maureen Prola-Tessaur of the outreach team at CERN were energetic, enthusiastic and highly efficient at creating an experience for all the participants that was not only educational but also truly inspiring.

CERN exemplifies scientific collaboration. The facility houses experts from around the world with a clear focus on exploring the unknown questions that still puzzles us today. CERN works to unravel the mysteries of our universe – making discoveries to answer the questions we have but also to seek out new discoveries that will lead us to profound new questions. CERN continues to test and push the physics ideas we know today and innovate new technologies to make these explorations possible. Teams of physicists, engineers, technicians, computer scientists, and data scientists work together to make CERN a cutting edge research destination. The three week High School Physics Teacher Program provides an intensive, behind the scenes look into the world of particle physics and cutting edge research.

Summary

As a result of winning the Ontario Excellence in High School/CEGEP Physics Teaching Award by the Canadian Association of Physicists, I attended the High School Physics Teacher Program @CERN as the Canadian teacher participant! The three week program was action packed with lectures, facility tours, workgroup sessions and lots of discussions. Jeff Wiener and Maureen Prola-Tessaur of the outreach team at CERN were energetic, enthusiastic and highly efficient at creating an experience for all the participants that was not only educational but also truly inspiring.

The program can be found online and my adventures can be found on Twitter @llimcole. The program contains all the PowerPoint presentations from each of the lectures and additional supplemental resources that were shared during the experience.

The 2017 High School Physics Teacher Program (#HST2017)
https://indico.cern.ch/event/572852/timetable/

The program started with a brief introduction to particle physics. Jonathan R. Ellis from the University of London, and Kristof Schmieden from CERN led us through a series of highly informative lectures on the "basics of particle physics". The background provided set the stage for exploring the inner workings of CERN. The first tour was of the Synchrocyclotron. The stunning multimedia presentation provided a detailed tour of the 600 MeV Synchrocyclotron (SC) which was built in 1957. The SC provided beams for CERN's first particle and nuclear physics experiments. https://home.cern/about/accelerators/synchrocyclotron

Lisa Cole
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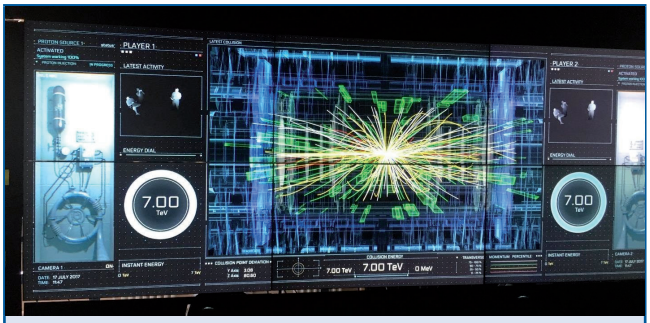


LHC Interactive Tunnel - Proton Football Work in Progress

During our time @CERN, we were challenged to work in groups to collaborate with CERN staff on various projects. The working groups provided an opportunity to network and meet people at CERN while contributing to some of the projects that are happening. I was part of the Media Lab work group. The Media Lab works to "Accelerate Science Education" by providing software development, hardware research and content creation. We worked with João Pequenão on developing the narrative of a component of the LHC Interactive Tunnel (LIT) (http://medialab.web.cern.ch/content/lhc-interactive-tunnel).

The LIT allows participants to engage in learning by entering the particle physics world in an immersive, interactive multimedia platform. The work group collaboratively developed a narrative to support the development of additional features to the Proton Football component of the tunnel. Proton Football allows participates to learn about what happens when protons are accelerated and a collision occurs. The harder the protons are kicked, the more energy you give the collision resulting in the production of more particles. With any public exhibit, it is important to tell a story that is captivating and exciting. The LIT hopes to capture the attention of public audiences in a way that not only entertains but also tells the story of discovery and quest for understanding the mysteries of our universe. What story is more exciting than the story of our universe?!

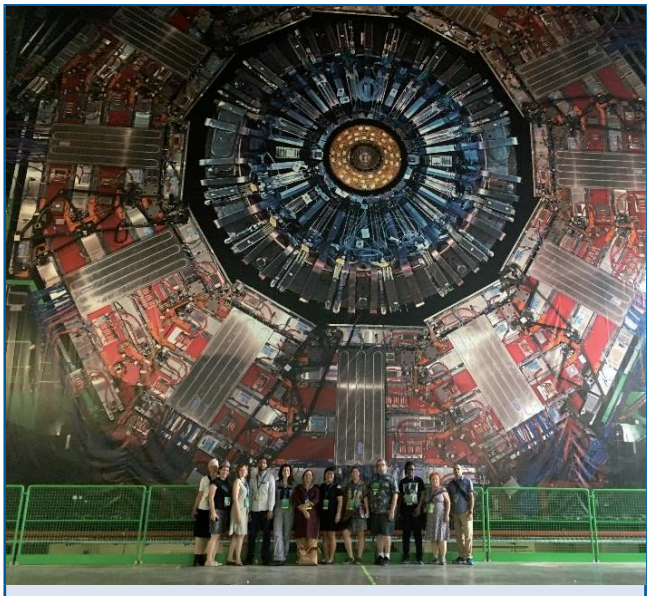
The equation $E=mc^2$ is famous! It is immediately recognized as some science thing and yet, it's true power and story is not commonly known. Let's imagine two watermelons accelerating towards each other. The combined energy of the two watermelons in the everyday world would make a messy explosion of watermelon parts if the watermelons collide.

Proton Cookies to keep us inspired!

However, in the particle world, the energy of the two watermelons would create a cascade of fruit salad where strawberries, oranges, peaches, apples and blueberries will emerge. And on occasion, something completely unexpected! …Maybe even a mouse! The larger the energy of the watermelons, the greater amount of fruit salad… or other things… At CERN, two protons are accelerated and collided with large amounts of energy to create new particles! Sometimes surprises are in store and new discoveries are made! The Higgs! The Ξcc^{++}($Xicc^{++}$)! You see, $E=mc^2$ is like a magic hat! You put a rabbit into the hat and you get horses, monkeys, elephants,

Media Lab Working Group Presentation, 2017

Antimatter...not science fiction!



Tour of the Compact Muon Solenoid (CMS)

dogs, cats and sometimes even a unicorn! The Media Lab Group works on developing creative and innovative ways to communicate complex scientific ideas. It was exciting to take part in this discussion and was inspired by the creativity and created proton cookies to help us work!

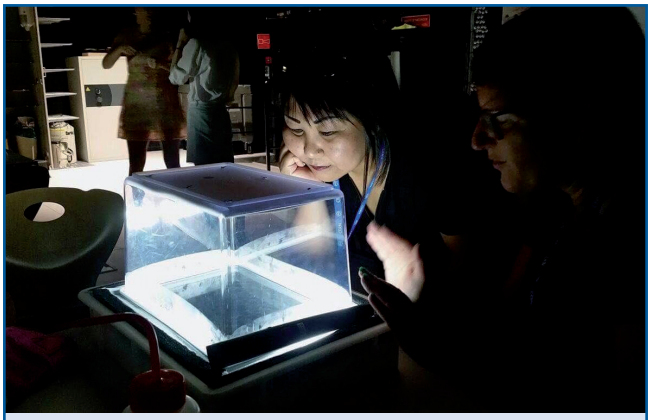
Each workgroup presented their projects on Thursday July 20 and Friday July 21, 2017. You can see a recording of each presentation at: https://indico.cern.ch/event/572852/timetable/.

Innovation drives CERN and continues to push the boundaries of discovery. Discoveries such as the Higgs particle helps to build better understanding about the universe we live in. In the quest to make new discoveries, innovations in medical physics, technology, data science and engineering have emerged to make global impacts. Examples such as Hadron Therapy, the World Wide Web, and touch screen technology would not exist without the innovative work of CERN.

During the three week intensive program, phenomenal visits to the Cryogenic Test Facility Hall (SM18), Compact Muon Solenoid (CMS) Service Cavern, Data Centre, CERN Control Centre & Alpha Magnetic Spectrometer (AMS) Payload Operation Control Centre (POCC), Isotope mass Separator On-Line facility (ISOLDE), Large Magnet Hall, Low Energy Ion Ring and the Antimatter Factory were conducted. The visits to the cutting edge facilities were led by CERN staff and provided opportunities to see where all the theory comes alive. The collaboration and team work necessary to orchestrate the synchronized process to make CERN work is truly a demonstration of human ingenuity.

Tour of ISOLDE

The Large Magnet Hall



Building a Cloud Chamber! It works!

Additional Information about Facilities

Cryogenic Test Facility Hall (SM18) – Testing magnets and instrumentation at low temperatures (1.9 K – 80 K) and high currents (20 kA)
https://espace.cern.ch/te-dep-msc-tf/SitePages/Home.aspx

CMS – The large detector that uses large solenoid magnets to bend the paths of particles from collisions in the Large Hadron Collider
https://home.cern/about/experiments/ams

CERN Data Centre – Heart of CERN's entire scientific, administrative and computing infrastructure
http://information-technology.web.cern.ch/about/computer-centre
https://home.cern/about/computing

CERN Control Centre
https://home.cern/cern-people/updates/2015/03/day-cern-control-centre

AMS – Looks for dark matter, antimatter and missing matter on the International Space Station
https://home.cern/about/experiments/ams

ISOLDE – Studies the properties of atomic nuclei
https://home.cern/about/experiments/isolde

The High School Physics Teacher program participants also engaged in education focused learning experiences during the program. We had an opportunity to build a cloud chamber in the S'Cool Lab. S'Cool Lab is truly a learning environment that would be envy of any Science Teacher.

I was thrilled to also connect with Perimeter Institute for Theoretical Physics (PI) during the full day workshop led by Greg Dick and Dave Fish. The outreach team from PI engaged all the participants with great instructional strategies and resources for practical implementation into the classroom. The classroom tested resources are free and can be found on their website at https://www.perimeterinstitute.ca/outreach.

The three week High School Physics Teacher Program at CERN was truly a dream come true for a physics educator. It was a an experience that really challenged me to learn more about particle physics and more importantly reflect on the importance of exposing our youth and the public to the wonders of our universe and the quest for new discoveries. I have provided many links to various resources within this article for you to explore! Consider connecting with the Outreach Team at CERN, Canadian Association of Physicists and the Outreach Team at Perimeter Institute for Theoretical Physics! Also consider connecting with me through my current role as the Education Officer at the Ontario Ministry of Education, at lisa.s.cole@ontario.ca. There is a wealth of knowledge, an enthusiastic network of professionals and unlimited possibilities to explore!

Additional Online Resources to Explore

Canadian Association of Physicists
https://www.cap.ca/

Perimeter Institute for Theoretical Physics
https://www.perimeterinstitute.ca/outreach

International Teacher Programs at CERN
http://teacher-programmes.web.cern.ch/itp/international-teacher-programmes

S'Cool Lab
http://scool.web.cern.ch/

S'Cool Lab Experiments
https://scool.web.cern.ch/experiments

Classroom Activities and Downloads
https://scool.web.cern.ch/content/downloads

Beamline for Schools Competition
https://scool.web.cern.ch/content/beamline-schools-competition-2018-apply-now

Exploring Classroom Resources with Greg Dick and Dave Fish from Perimeter Institute in S'Cool Lab, CERN

Curved Spacetime! Party in the Physics Classroom with Perimeter Institute

S'Cool Lab Days at CERN Application
http://scool.web.cern.ch/content/about

CERN Visits http://visit.cern/ CERN Media Lab
http://medialab.web.cern.ch/

Charming New Discovery - Ξcc^{++}(Xicc^{++})
https://home.cern/about/updates/2017/07/lhcb-announces-charming-new-particle

The Higgs boson
https://home.cern/topics/higgs-boson

International Particle Physics Outreach Group (IPPOG)
http://ippog.org/

art@CMS – art of science, beauty in creation
http://artcms.web.cern.ch/artcms/

Inclusive Physics Teaching – Share your story!
http://www.inclusivephysics.org/

CONGRATULATIONS

2017 Prize Winners / Gagnants des Prix de 2017

University Prize Exam Results 2017 – *Résultats de l'examen du prix universitaire 2017*

This year, 74 students from 16 post-secondary institutions completed the exam held on February 7, 2017 which was run by representatives from the University of Toronto / Cette année, 74 étudiants de 16 universités ont participé au concours universitaire qui a eu lieu le 7 février 2017 et qui a été administré par l'Université de Toronto.

Miles Cranmer	**First prize / *Premier prix***	**McGill University**
Andrew Gomes	**Second prize / *Deuxième prix***	**University of Toronto**
Hiromitsu Sawaoka	**Third prize / *Troisième prix***	**University of Toronto**

4. Chris Gustin	Queen's University	8. Jomar Sastrillo	Simon Fraser University
5. Sam Abernathy	Queen's University	9. Gavin Crowder	Queen's University
6. Beichong Lou	University of Toronto	10. Samuel Leutheusser	University of British Columbia
7. Matthew Basso	UBCO		

CAP High School Prize Exam – *l'examen du secondaire ou collégial de l'ACP*
2017 National Winners – *Gagnants 2017 à l'échelle nationale*

First prize / *Premier prix*	Guo Ming Zheng, Richmond High School, Richmond Hill, ON
Second prize / *Deuxième prix*	Ming Yange Ye, Bayview Secondary, Richmond Hill, ON
Third prize / *Troisième prix*	Pedram Amani, West Vancouver Secondary, West Vancouver, BC

2017 Canada-wide Science Fair – *2017 Expo-sciences pan Canadienne*

The 2017 Canada-wide Science Fair was held from May 15-20 in Regina, SK. This year the CAP, though the CAP Foundation, sponsored prizes at each of the "senior", "intermediate" and "junior" levels. Congratulations to the following recipients, pictured below.:

Senior CAP Physics Prize – Marin Schultz, Lethbridge, Alberta

Project: Novel Prosthetic AutoGrasp Control System and Human-Prosthetic Interface

Biography: Marin Schultz loves building robots and computer programming. Ever since he realized first-hand that inventions can have a real-world impact and help people, he has been inspired to build prosthetics in particular. He has won several national and international awards for his inventions including

From left to right: Marin Schultz, Melody Cheng, Daniel Kornylo (Presenter: Dr. Ben Newling-Youth Science Canada, National Judging Committee).

previous CWSFs. When not inventing, Marin's favourite thing to do is read philosophy, history and poetry. His interest in advanced prosthetic design stems from his desire to help a one-handed friend from Lethbridge who visited his 2012 science fair project involving EEG sensors and robotics. He hopes to inspire other students to learn, and to be excited and passionate about helping others through science

Abstract: This project proposes a novel AutoGrasp control system that allows a prosthesis to autonomously grasp "Smart Objects" thereby increasing the complexity of the movements achievable with simple sensory input. It further proposes a human-prosthetic interface, in the form of a touchscreen, that functions as visual sensory feedback. Underactuated prosthetic fingers were developed that exhibit self-adaptive behavior and enable the prosthetic to grasp objects reliably.

Intermediate CAP Physics Prize – Melody Cheng, Victoria, BC

Project: A New Phase of Water: Is this measurable with surface tension?

Biography: Melody Cheng wanted to expand her knowledge about water. Her project was inspired by an article she read about scientists that found evidence of a new phase of water (published in November 2016). She hopes that in the future we as human beings will have the opportunity to explore and understand the topic fully. For Melody, the essential thing for doing a science project is an open, passionate heart towards the subject.

Abstract: Recently, scientists discovered a new phase of liquid water, where a difference in hydrogen bonding exists from 40 to 60C. I wanted to know if this phenomenon could be observed in different concentrations of magnesium chloride and sodium chloride. I measured the surface tension of water by analyzing the contact angle in a droplet and was able to measure a variation in the crossover temperature.

Junior CAP Physics Prize – Daniel Kornylo, Gold River, BC

Project: High School Voltage

Biography: Daniel Kornylo is a science enthusiast, a figure skater, and a grade 8 student at Gold River Secondary School. He lives in a remote location on Vancouver Island where there is no cellular service. Initially, he wanted to do a project on the repair of his classroom Van de Graaff generator. As he learned more about electrostatic generators, he found out that there had been other types, such as the Pelletron and the Laddertron, which have been used in particle accelerators. This caused him to wonder if it would be possible to build a classroom electrostatic generator using a Laddertron style of belt. His advice to students that are thinking of doing a project like this is to first make sure they are interested in the subject area and that they never give up.

Abstract: Following the repair and refit of a vintage Van de Graaff generator, a hybrid educational electrostatic generator was constructed. This device uses a Laddertron style of charge transport system within the familiar Van de Graaff framework. As an added educational feature, a remote control allows students to vary the inducing voltage, and its duty cycle, as well as the belt speed

The 2018 Canada-Wide Science Fair will be held in Ottawa, ON.

News from the Canadian National IUPAP Liaison Committee

by Rituparna Kanungo and Jens Dilling

The 29th IUPAP General Assembly was held in Sao Paulo, Brazil, during 11-13 October 2017. Eleven commission members from Canada were elected for the term 2018-2020.

Dr. Jens Dilling, Chair of the Canadian National IUPAP liaison committee led the delegation representing Canada.

At this meeting, eleven commission members from Canada were elected for the term 2018-2020. Canada continues to have excellent representation on these important commissions, more than the 'recommended guideline' numbers from IUPAP. This speaks to the quality and reputation of the Canadian nominees and our standing in the world for the election process. The following members were elected (new members are indicated) and we have a 36% female ratio for the Canadian members.

C2	Dr. Ania Kwiatkowksi (new)
C8	Dr. Andy Sachrajda
C9	Dr. Can Ming Hu
C10	Dr. Graeme Luke (new)
C11	Dr. Brigitte Vachon (new)
C12	Dr. Iris Dillmann (new)
C13	Dr. Michael Steinitz
C14	Dr. Tetyana Antimirova
C16	Dr. Robert Fedosejevs
C17	Dr. John Ozaki
C18	Dr. Manu Paranjape (new)

More information about the General Assembly and resolutions taken, can be found here:

http://iupap.org/general-assembly/29th-general-assembly/

CAP extends congratulations to them and also to Dr. Dilling for his leadership in the process. Dr. Dilling will continue serving in the committee as the past Chair from 2018.

Dr. Rituparna Kanungo is the incoming Chair of the Canadian National IUPAP liaison committee from 2018.

The Canadian delegation in front of the Presidents Bell and Building of the Universidade de Sao Paulo at the 2017 IUPAP General Assembly in Brasil. Left to right : Andrew Sachrajda, Willem Van Oers, Jens Dilling, Tsuneyuki (John) Ozaki

The Editorial Board welcomes articles from readers suitable for, and understandable to, any practising or student physicist. Review papers and contributions of general interest of up to four journal pages in length are particularly welcome. Suggestions for theme topics and guest editors are also welcome and should be sent to bjoos@uottawa.ca.

Le comité de rédaction invite les lecteurs à soumettre des articles qui intéresseraient et seraient compris par tout physicien, ou physicienne, et étudiant ou étudiante en physique. Les articles de synthèse d'une longueur d'au plus quatre pages de revue sont en particular bienvenus. Des suggestions de sujets pour des revues à thème sont aussi bienvenues et peuvent être envoyées à bjoos@uottawa.ca.

Summary of the 52nd Annual Canadian Undergraduate Physics Conference at Dalhousie University in October 2016

by Carmen Lee, Dalhousie University

The Canadian Undergraduate Physics Conference (CUPC) was held at Dalhousie University from October 13-16, 2016. There were 124 undergraduate attendees who represented 29 universities from across Canada. The CUPC is an annual research conference targeted toward undergraduate physics student which is organized by fellow students.

Academic conferences like the CUPC provide excellent opportunities for students to present their research, network with their peers and to engage with members of the scientific community. Often, this is one of the first academic conference that many aspiring physicists attend.

The conference included talks given by both students and four plenary lecturers. Student presentation topics ranged from astrophysics, applied physics, biophysics and soft condensed matter, quantum condensed matter, and particle and nuclear physics. Prizes were awarded for the best presentations in each of these categories, as well as for the student poster fair. As many students were presenting from different research labs from across Canada, the breadth of field of the areas of physics covered was extensive.

The four plenary lectures were given by Andrew Rutenberg (Dalhousie University) on "Watching spherical cows die: the physics of aging", a presentation on using physics to predict mortality rates. Arthur Carty (Waterloo Institute for Nanotechnology) presented on "Building a World Class Nanotechnology Institute: Meeting the Challenges of Interdisciplinary Culture and Innovation in WIN". In this talk, Dr. Carty discussed the Waterloo Institute for Nanotechnology and the efforts that went into its conception. Eden Full Goh (SunSaluter) presented a lecture entitled "A Work in Progress", where she discussed her technology for using solar power to filter water, and the non-profit organization that has made to deploy it to developing nations. The final plenary lecturer was Eli Yablonovtich who presented a talk on "Optoelectronics: Is there anything it cannot do; Can Opto-Electronics Provide the Motive Power for Future Vehicles?", who discussed the principle behind solar cells and how the most efficient are also the best LEDs.

Summary

The Canadian Undergraduate Physics Conference (CUPC) was held at Dalhousie University from October 13-16, 2016. There were 124 undergraduate attendees who represented 29 universities from across Canada.

Attendees were invited to ask questions from our career panel composed of four individuals with careers in physics or engineering. Panelists included Eden Full Goh, Jordan Kyriakidis, Kimberley Brewer, and Jeff Dahn. Breakout sessions offered students perspectives on grad school, politics in science, and diversity in physics. This was one of the activities that received the most positive response from participant feedback. These were new to the conference this year, and provided attendees with an informal opportunity to discuss graduate studies, diversity in physics and politics in science. Four Dalhousie physics professors led these and encouraged open discussion and questions about the topics at hand. These professors were Rachel Chang, Kevin Hewitt, Theodore Monchesky and Thomas Duck. We hope to see these sessions continue with future CUPCs.

While on Dalhousie campus, students toured 6 different research labs whose area of focus ranged from ultrafast

Carmen Lee <carmen.lee@dal.ca>, Department of Physics and Atmospheric Science, Dalhousie University, Halifax, NS B3H 3R2

optics, biophysics and even marine biology. Students interacted with-graduate representatives from about 20 Canadian Universities at the grad fair, a valuable resource for those students considering graduate school. Students experienced the Halifax nightlife during organizedsocial events. We embarked on a tour of Citadel Hill, a historic site overlooking downtown Halifax. The conference was capped off with a banquet, where student awards were announced, and the conference came to a close. Response from our participants has been generally positive, with one stating that, "It was well organized, awesome hotel, good food, Halifax was an excellent city to be in, lots of interesting presentations given. I particularly enjoyed the plenary lecture at the banquet dinner."

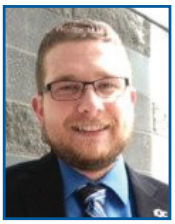
The organizing committee of CUPC 2016 would like to extend our gratitude toward our generous sponsors including the Fields Institute, the Canadian Association of Physicists, Dalhousie University, the Canadian Astronomical Society, TRIUMF, the Canadian Light Source and the Canadian Journal of Physics.

Opening night of CUPC 2016 before the Plenary lecture given by Dr. Rutenberg.

Plenary speaker Dr. Yablonovich (left) and CUPC committee member Michael Lynch (right) at the CUPC banquet.

The 2017 Canadian-American-Mexican Graduate Student Physics Conference

by Chris Pugh



The theme of the conference was "Physicists of the Future: Transcending Boundaries." This topic is always relevant as many physicists travel the world performing and presenting research and collaborating with many people from many countries. The panel discussions on "Geographical, Disciplinary & Career" boundaries and "Personal and Societal: Life as a Graduate Student in Canada, Mexico, Cuba and the United States" were especially interesting and the focus on graduate students was, as is always the case at this conference, extremely important to hear. Learning about the experiences of graduate students from the other countries provides insights into how different our research lives can be just based on where we are located.

Thursday morning the conference kicked off with welcome remarks from each of the organizations followed promptly by the first plenary speaker. Each day was jam packed with student talks as well as a poster session on Friday, but there were many coffee breaks to allow for fruitful discussions to take place. The conference banquet took place at the Capitol Hill Rayburn House Office, a short walk from the hotel past the United States Capitol Building. The only rain during the entire conference happened during this walk, but the APS organizing team had somehow predicted this perfectly and supplied ponchos and umbrellas for each of the participants!

The Canadian delegation were each supplied with a Canada 150 t-shirt and we wore these shirts to the conference welcome reception on Thursday to identify ourselves as the Canadian delegation. Our plenary speakers were also supplied with these shirts to provide us with a unique identifier at the conference.

Overall, the conference was an extremely positive experience for all those involved where students from Mexico, the United States, Cuba and Canada came together to share their research. The specific focus on graduate students is extremely beneficial and can really help students gain an international perspective on physics research across North America. I would like to thank the organizers, especially from the American Physical Society and Dr. Krista Freeman for the wonderful conference. Thank you also to the Canadian sponsors who helped provide travel support for our Canadian delegates including the Canadian Association of Physicists (CAP), the CAP Foundation, and SNOLAB.

We look forward to seeing many more students attend the 2019 CAM (possibly soon to be known as C^2AM) which will be hosted either in Canada or, possibly, Cuba!

Summary

13 young Canadian physicists attended the biennial Canadian-American-Mexican Graduate Student Conference in Physics from August 17-19, 2017, in Washington, DC.

Chris Pugh <pughc@brandonu.ca>.
At the time of the conference, Chris was with the Physics Department, University Waterloo, Waterloo, ON

Report on Canada's Participation in the 48th International Physics Olympiad in Yogyakarta, Indonesia

By Andrzej Kotlicki

The 48th International Physics Olympiad (IPhO) was held from July 16th to 24th, 2017 in Yogyakarta, Indonesia. Again, this year due to the generosity of our sponsors we were able to organize the Canadian Olympiad Finals in Vancouver. The students who were invited to the finals at our cost were the top scorers of the Canadian Association of Physicists (CAP) High School Exam. 859 students from 162 Canadian schools wrote the exam this year (just few more compared to last year), and the top 12 students were invited to the National Finals in Vancouver. After 6 days of lectures, 3 theoretical exams, and 2 experimental exams, the Canadian Team for the International Physics Olympiad was selected. The National Final was organized with great help from UBC professor Joanna Karczmarek, the IPhO medalists: a UBC TA Koosha Rezaiezadeh and Sepehr Ebadi (who just graduated from UoT, and UBC COOP student Eric Neal.

The limited funding did not allow for any additional training for the full team before the trip to Indonesia, however, Koosha did some experimental training for Pedram, who started his preparation for Olympiad, while still in Iran at Atomic Energy High School. Three of our students (Henry Tang, Jerry Guo and Ming Yang Ye) got additional training at the York University and all Toronto students got great preparation in Toronto's afterhours schools: Olympiads school and Ivy Path School.

It is worth mentioning that teams from other countries are given anywhere from 2 weeks to 2 years of additional training for this competition.

Summary

The 48th International Physics Olympiad (IPhO) was held from July 16th to 24th, 2017 in Yogyakarta, Indonesia. The Canadian team did very well in the competition considering the limited training. Next year, Portugal will host the IPhO in Lisbon. Canada looks forward to participating in 2018.

Andrzej Kotlicki, <kotlicki@physics.ubc.ca>

Department of Physics, University of British Columbia 6224 Agricultural Road, Vancouver, BC V6T 1Z1

The members of the Canadian team this year were:

Ming Yang Ye a student of William Dykshoorn from Bayview Secondary

Pedram Amani student of Jeff Green from West Vancouver Secondary

Yuheng (Jack) Xu a student of Raymond Fung from Unionville High School

Henry Tang a student of Henri Van Bemmel from Marc Garneau Collegiate

Guo Jerry Zheng student of Roy Karo from Richmond Hill High School

The team leaders were Dr. Andrzej Kotlicki (UBC), Director for the Canadian Physics Olympiad Program, and Koosha Rezaiezadeh, UBC engineering student and TA and past IPhO gold medalist from Iran.

The observers were:

Yadong Jiang and Ryan Lin from the Olympiads school in Toronto

This year we were able to pay for the trip to the IPhO for all of students and Koosha while A.K. and the two observers paid for their travel and the observer's fees.

This year's IPhO was hosted by Ministry of Education and Culture, Republic of Indonesia and Universitas Muhammadiyah Yogyakarta. The opening and closing ceremonies took place at the elegant Sahid Rich Jogja hotel, where all the students were housed. Both were enlivened by local traditional and modern music and dance performances.

Eighty-six countries sent teams of students to this year's Olympiad. According to the IPhO's rules, roughly 67% of the participants were awarded Olympic medals or honorable mentions.

As usual, the competition had both theoretical and experimental parts that were meant to challenge students at a

level more advanced than typical high school or even first year university physics exams. The competition consisted of 3 theoretical and 2 experimental problems.

One experimental problem was investigating the properties of the diamagnetic levitator based on the field from two cylindrical magnets. This question was very interesting, educational and well prepared. The other one was asking students to measure the refractive index gradient and a diffusion coefficient of the salt solution using the optical effects. This question was also interesting and educational but poorly written and needed a lot of corrections.

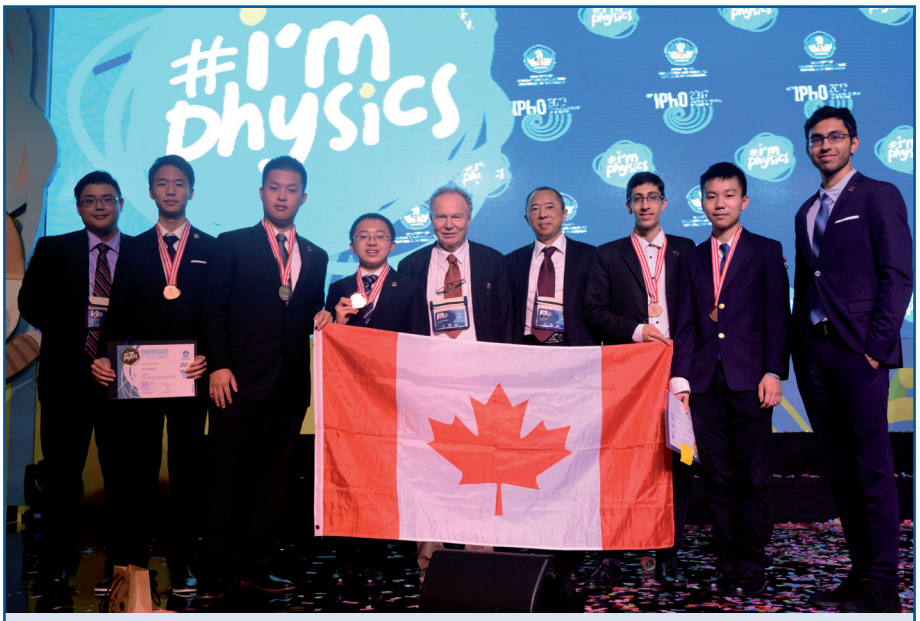


Fig. 1 The Canadian Team with medals after the Closing Ceremony. From the left: Ryan Lin, Ming Yang Ye, Guo (Jerry) Zheng, Henry Tang, Andrzej Kotlicki, Yadong Jiang, Pedram Amani, Yuheng (Jack) Xu and Koosha Rezaiezadeh.

The final text was accepted by the International board very late and the translation to the various languages of the students was not finished until 6 AM (not unusual in IPhO). Copying of the exam was not properly done and the exam, which should have started at 9 AM, was postponed until next day. It meant that there was no free day between the experimental and theoretical exam.

There were three theoretical problems prepared by the organizers. The first one dealing with the telescope had very little conceptual content and required very long purely trigonometrical calculations and was rejected by the International board. It was replaced with a very poorly prepared inflation of the Universe problem. Fixing it with the great help from the Hong Kong leader, who was an expert in this field took again a very long time. The second problem on Earthquakes, volcanos and tsunamis was very good and well written. The third one on Dark Matter needed more corrections. Again, the final text was accepted by the International board very late and the translation to the various languages of the students was not finished until 6 AM. Unfortunately copying and distributing the problems to the students was very poorly organized and many students were supplied with wrong translations or none at all.

The marking by the organizers was very inconsistent and the differences between the organizers and leaders marking (including marking of our teams' papers) were unusually large. In this situation, the international board decided, on the suggestion of the president, that the medals will be awarded by the President and the Secretary of the IPhO based mainly on the leaders marking and taking into account the difficulties some non-English speaking students had working only from the English text. The International board did not consider or approve the choice on absolute winners and therefore these results, announced at the closing ceremony are not official.

To be fair, one should mention that Indonesian organizers had less time than most others, as Indonesia volunteered to organize the 2017 competition, when another country withdrew in the last moment.

Our team did very well in the competition considering the limited training. Ming Yang Ye got a gold medal, Guo (Jerry) Zheng a silver and all the others bronze medals.

After the exams, the students enjoyed interesting excursions to the famous Borobudur temple, the Indonesian air force museum and to the center of town market. There was also a lot of socializing including a "midterm" party with very good music. The local guide Ganis Agil Ramadhan took very good care of our students.

Next year, Portugal will host the IPhO in Lisbon. Canada looks forward to participating in 2018.

Theory CANADA 12 Conference: Building Community from British Columbia to Newfoundland

by Matthew Johnson and Svetlana Barkanova

Matthew Johnson <mjohnson@perimeterinstitute.ca>, York University, Toronto, ON M3J 1P3 (Also affiliated with Perimeter Institute)

Svetlana Barkanova <sbarkanova@grenfell.mun.ca>, Memorial University of Newfoundland, St. John's, NL A1C 5S7

Summary

The Theory CANADA conference, launched in 2005 as a satellite conference for the annual Canadian Association of Physicists (CAP) Congress, was yet another success in 2017. The Theory CANADA Conference 12 conference was held at York University on May 26 and 27, 2017. It featured 9 invited speakers and 28 contributed talks.

The Theory CANADA conference, launched in 2005 as a satellite conference for the annual Canadian Association of Physicists (CAP) congress, was yet another success in 2017. This unique conference brings together theorists from all regions of Canada, aiming to foster collaboration and exchange of ideas across many disciplines. What makes it special is that all the sessions of the conference are plenary, with no parallel talks, so Theory CANADA is bringing together community not only from all across Canada, but also from across various areas of theoretical physics, ranging from cosmology to quantum information.

The Theory CANADA Conference 12 conference was held at York University on May 26 and 27, 2017, chaired by Matthew Johnson (Perimeter Institute and York University) assisted by a strong team from York (Marko Horbatsch, Tom Kirchner, Roman Koniuk, Randy Lewis, Kim Maltman, Sean Tulin) and the DTP Executive (Svetlana Barkanova, Memorial University of Newfoundland and Ariel Edery, Bishops University). York University turned out to be a wonderful conference venue, with easy access from Toronto Pearson airport, modern residences, and many restaurant options nearby.

The conference was sponsored by the Fields Institute, Perimeter Institute for Theoretical Physics, Canadian Institute for Theoretical Astrophysics, Institute of Particle Physics, York University Faculty of Science, and Centre de Recherches Mathématiques who were crucial in making this conference a success.

The conference featured 9 invited speakers and 28 contributed talks. Most of the contributed talks were delivered by graduate students and postdocs, making this conference an important training opportunity for future leaders in the Canadian theoretical physics community. A total of 70 participants registered, with representation from many regions of Canada (Ontario, Quebec, Newfoundland and Labrador, Manitoba, Nova Scotia, and British Columbia). We had especially good representation from the Perimeter Institute faculty, postdocs and students, with 15 in total attending from PI. As it is customary for Theory CANADA, the six sessions represented the areas of Mathematical Physics, Quantum Foundations and Quantum Information, Cosmology, Gravity, and Astrophysics, Condensed Matter Physics, Nuclear and Particle Physics, and String Theory and Quantum Gravity. Talks were intended to be accessible to attendees outside of the speaker's field. Speakers made a great effort at this, and many attendees expressed that they learned something truly new. A full schedule of the talks can be found at http://cosmo.phys.yorku.ca/schedule.html.

Some of the scientific highlights of the event included: a sequence of contributed talks by Angelika Fertig (postdoc, Perimeter Institute) and Job Feldbrugge (PhD student, Perimeter Institute) describing exciting new ideas about the role of lorentzian path integrals in quantum theory and quantum gravity; an extremely clear and topical talk by Eric Poisson (faculty, U Guelph) about tidal deformations of neutron stars in their merger; a sequence of contributed talks by Laszlo Zalavari and Peter Hayman (PhD students, McMaster) on the use of effective theory in understanding various singular properties of charged point particles; an invited talk by David Morrissey (faculty, TRIUMF) on non-abelian gauge bosons in dark sectors; and an invited talk by Brandon van Zyl (faculty, St. Francis Xavier) on many-body quantum effects in a bilayer system of dipolar fermions which generated a number of interesting questions from

theorists outside his field. Overall, the quality of both the invited and contributed talks were exceptional.

The Theory CANADA 13 will be hosted by St. Francis Xavier University (Antigonish, Nova Scotia), in June 7-9, 2018, right before the CAP Congress hosted by Dalhousie University (Halifax, Nova Scotia) in June 11-15, 2018, with no registration fees for the CAP Congress delegates. Please see http://physics.stfx.ca/TC13/ for details. One of the features of the TC13 conference will be an invited talk from the winner the DTP/WITP Ph.D. thesis prize awarded to a student receiving a Ph.D. degree in the current or prior calendar year. For more information about the prize, please see http://www.cap.ca/en/div/dtp/thesis-prize.

As usual, Theory CANADA will strive to sponsor accommodations for invited speakers, graduate students and postdoctoral fellows, and, funding permitting, accomodation to all participants. Please contact the TC13 conference chair, Peter Marzlin, Department of Physics, St. Francis Xavier University, pmarzlin@stfx.ca, for details. The Atlantic GR conference will also take place at StFX on June 5-6, right before TC13. Please contact Robert van den Hoogen at rvandenh@stfx.ca for more information.

We greatly thank all Theory CANADA 12 attendees, speakers, and sponsors for making this event a great success, and hope Theory CANADA 13 will be just as enjoyable.

CAP Foundation – Board Of Directors' Annual Report 2016[1]

ABOUT THE CAP FOUNDATION

The CAP Foundation is a registered charity[2] administered by a Board of Directors elected by the CAP Board. Income from donors and corporate sponsors, supplemented by targeted fundraising campaigns, is allocated to key activities in education and outreach undertaken in support of Canadian Physics.

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The CAPF Treasurer is David Lockwood, P.Phys., from NRC; the Executive Manager is Francine Ford from the CAP.

Executive Summary

The 2016 calendar year was the CAP Foundation's third full year of operation. It was a year of intense activity in which the Foundation Board launched its first major fundraising campaign, oversaw delivery of its existing suite of activities to enhance and enrich physics education in Canada, and laid the groundwork for new educational initiatives in support of the CAP's strategic plan. During 2016, the CAPF Board met 19 times. Two of these meetings (at Congress in Ottawa and late September in Toronto) were attended in person by many Board members and the rest of the meetings were carried out by teleconference.

Based on planning undertaken in 2015, the CAPF launched its *Ignite the Spark* fundraising campaign just before the 2016 CAP Congress. The impact of this campaign was substantially increased by the agreement of the Carswell Family Foundation to match donations to the CAPF (up to $50,000) made in response to this campaign. The CAPF Board is deeply grateful for advice and support from Dr. Alan Carswell that made this result possible. The initial success of the *Ignite the Spark* campaign has provided the CAPF with resources to pursue new initiatives to help Canadian students understand the impact of an education in physics and to enrich the experience of that education. As of early 2017, implementation of some new initiatives, including a poster distributed to all Canadian high schools, a series of short videos profiling physicists pursuing non-academic career opportunities, and the organization of student-industry connector events is already underway.

The CAPF Board is grateful to the many donors who, in 2016, supported the educational activities of the CAPF through donations at the time of their CAP membership renewals or in direct response to the *Ignite the Spark*

1 Publication of the 2016 CAPF Annual Report was rescheduled from the 2017 *Physics in Canada*, Vol.73, No. 2 to Vol.73, No. 4 due to a delay in the finalization of the 2016 financial statements. The 2017 report is scheduled to be published in the 2018 *Physics in Canada* Vol.74, No.2.
2 Charitable Registration #835627134RR0001.

campaign appeal. The CAPF Board is particularly grateful to Dr. Alan Carswell and the Carswell Family Foundation for their encouragement and remarkably generous support in this, the third full year of CAPF operation. The activities supported by the CAPF are only possible because of the substantial contributions of time and effort by individual CAP members, the CAP Board, and CAP staff members and the CAPF Board is deeply grateful for those contributions. The activities supported by the CAPF inspire students and educators to pursue excellence in physics teaching, learning and discovery. Students and educators alike are inspired and encouraged by the activities of CAPF to reach high goals in the research, teaching, and learning of physics in Canada. Ultimately, the objective of the CAPF is to contribute to Canada's capacity to meet future challenges by animating the next generation of physicists.

2016 ACTIVITIES

CAPF is the oversight body for major activities in education and outreach in physics that are consistent with the general mandate of the CAP. These activities are supported and administered by CAPF, assisted by targeted fundraising efforts and a contribution from the CAP General Fund. A list of CAPF-supported activities can be found at https://www.cap.ca/capf/. Some specific items funded in 2016 are described below.

Stoicheff Scholarship

Established in 2012 in memory of Dr. Boris Stoicheff, this award is given annually to an outstanding graduate student demonstrating both research excellence and significant service to the optics or physics community. The 2016 Stoicheff Scholarship was administered by the CAP Foundation and was awarded to Christopher Pugh of the University of Waterloo for his research and novel technological developments related to long distance transmission of entangled photons and foundational tests of three-photon entanglement as well as for his contributions to both the physics and broader communities.

Undergraduate Lecture Tour

The national Undergraduate Lecture Tour is the largest program under the aegis of the CAPF. Costs are shared with participating Physics Departments, with additional funds to support this event raised each year in collaboration with industrial sponsors and government as appropriate. The 2016 tour consisted of lectures given by 17 different speakers in 51 physics department in Canada (see https://www.cap.ca/programs/cap-lecture-tour/2016-lecture-tour-schedule/).

Prizes and Awards

In 2016, the Annual CAP prize exam competitions were held at both the high school and university level. For the High School Prize Exam, the prizes ($500, $300, and $200, respectively) for the top three national results were awarded to three students, all from Ontario. In addition, the CAPF awarded three prizes ($250, $150, and $100, respectively) for the top three results in each of the 10 provinces. In 2016, the CAP Lloyd G. Elliot University Prize Exam was coordinated by the Department of Physics at the University of Waterloo and was held on February 2, 2016. The exam was written by 77 students from 14 universities/colleges. In 2016, the winner of the 1st prize in this competition was Simon Axelrod, Queen's University. The 2nd and 3rd place winners, respectively, were Chris Ni, University of Toronto, and Sam Leutheusser, University of British Columbia. Full details for both the high school and university-level prizes can be obtained at https://www.cap.ca/programs/medals-and-awards/prizes-students/.

The **CAP Award for Excellence in Teaching High School/ CÉGEP Physics** was introduced in 2010. The award continues to gain recognition in high schools and CEGEPs across Canada. It is currently sponsored at the national level by the CAP, TRIUMF, Perimeter Institute, the Institute of Particle Physics, and at the regional level by the Association of Professional Engineers and Geoscientists of BC and includes a grant and an invitation to participate in one of five training opportunities offered at CERN, SNOLAB, TRIUMF, Canadian Light Source (CLS), or Perimeter Institute (PI).

In 2016, the five outstanding teachers from across Canada that received this award were:

Favian Yee, North Delta Secondary School for British Columbia and Yukon
Jeff Goldie, Strathcona High School for the Prairies and Northwest Territories
Christopher Meyer, York Mills Collegiate Institute for Ontario
Rhys Adams, Vanier College for Quebec and Nunavut
Steve Greer, Charles P. Allen High School for the Atlantic

Jeff Goldie was selected to receive the 2016 Perimeter Institute Physics Education Scholarship which includes travel support (provided by Perimeter Institute, CAP, and the Institute for Particle Physics) to attend a special three-week international workshop for high school teachers hosted by CERN, the world's premier particle physics laboratory located in Geneva and an opportunity to attend the 2017 Perimeter's Einstein Plus camp. Jeff Goldie's report on the 2016 workshop was included in *Physics in Canada*, Volume 73, No. 1 (2017). Steve Greer was also able to take advantage of a 5-day research opportunity at the CLS in December 2016.

Conference Support

The 52nd Canadian Undergraduate Physics Conference (CUPC) was held at Dalhousie University in October 2016 with 124 undergraduate attendees from 29 universities. CAPF provided financial support to assist student participants attending the conference. In addition to student presentations, there were four plenary lectures. These were presented by Andrew Rutenberg, Arthur Carty, Eden Full Goh, and Eli Yablonovitch A report on the 2016 CUPC appears in this issue of *Physics in Canada.* CAPF provided financial support to assist student participants attending the conference. The 53rd conference was held at Carleton University in October 2017 (a report is scheduled to be published in the 2018 Vol.74, No.2 issue of *Physics in Canada*).

The Canada-America-Mexico Graduate Student Conference is held every second year and there was no CAM Graduate Conference in 2016. The next CAM Conference was held in August 2017, in Washington, DC. A report on that conference is scheduled to be published in the 2018 Vol.74, No.2 issue of *Physics in Canada*.

CAPF FINANCES

The 2016 calendar year was one of transition for the CAPF. One of the exciting developments with regards to CAPF fundraising during 2016 occurred in March when the Carswell Family Foundation (CFF) generously agreed to match donations to the CAPF above its normal donation levels for the year (up to $50,000). This substantially raised the profile of the *Ignite the Spark* fundraising campaign which was then launched just before the 2016 CAP Congress. These funding developments resulted in donations to CAPF increasing to $66,375, for 2016, compared to $14,330 for 2015. The 2016 donation level includes member donations at the usual level, member donations in response to the *Ignite the Spark* campaign appeal, and a donation, from the Carswell Family Foundation, matching the latter amount.

Investment income also increased significantly from $323 in 2015 to $9,384 in 2016. On the other hand, corporate membership revenue declined from $4,250 in 2015 to $2,750 in 2016 and there was no revenue associated with the CAM Graduate Student Conference since it is only held in odd-numbered years. The overall result of these developments was an increase in total revenue from $37,188 in 2015 to $95,263 in 2016.

Following the 2016 CAP Congress, there was considerable planning activity for the initiatives targeted by the fundraising campaign but significant spending for those initiatives did not start until after the end of calendar year 2016. As a result, the level of expenses for 2016 was similar to that for 2015. There was a decrease in administrative and other expenses from $10,284 in 2015 to $6,475 in 2016. This reflects, in part, expenses incurred in 2015, but not in 2016, that were associated with preparations for the *Ignite the Spark* campaign launch. Another expense which was incurred in 2015, but not in 2016, was the expenditure of $8,763 associated with the 2015 CAM Graduate Student Conference. There were, on the other hand, some expenses that were higher in 2016 than in 2015. Professional fees rose from $20 in 2015 to $5,136 in 2016. The awarding of the Stoicheff Scholarship resulted in an additional expense of $3000 in 2016 compared to 2015 when this scholarship was awarded by the Optical Society of America. Expenses for the CAP Lecture tour were $1,322 higher in 2016 than in 2015. The overall result was a slight decrease in total CAPF expenses from $53,399 in 2015 to $51,206 in 2016.

The net result of the activity described above is that CAPF revenues for the 2016 calendar year exceeded expenses for the same period by $44,057. It is expected that the

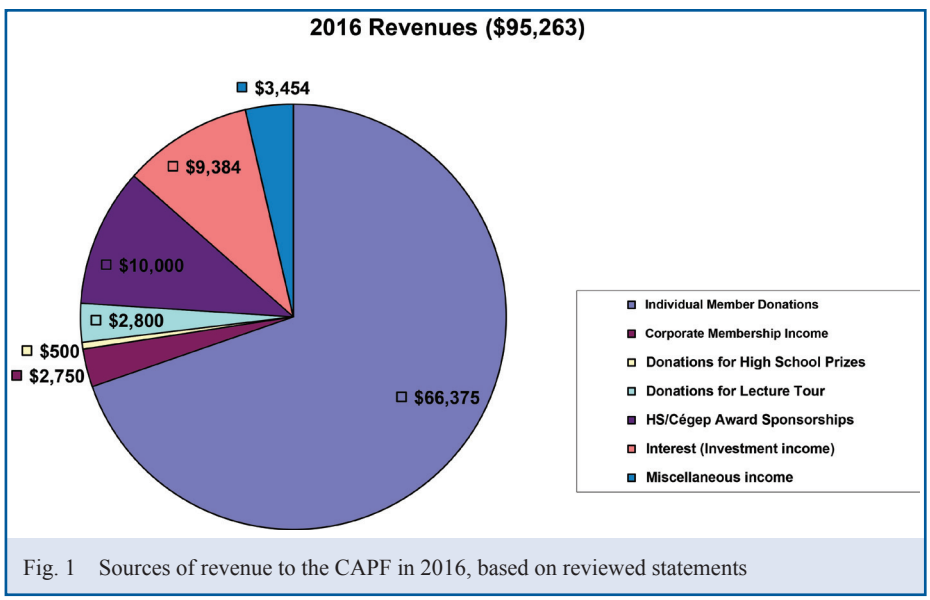

Fig. 1 Sources of revenue to the CAPF in 2016, based on reviewed statements

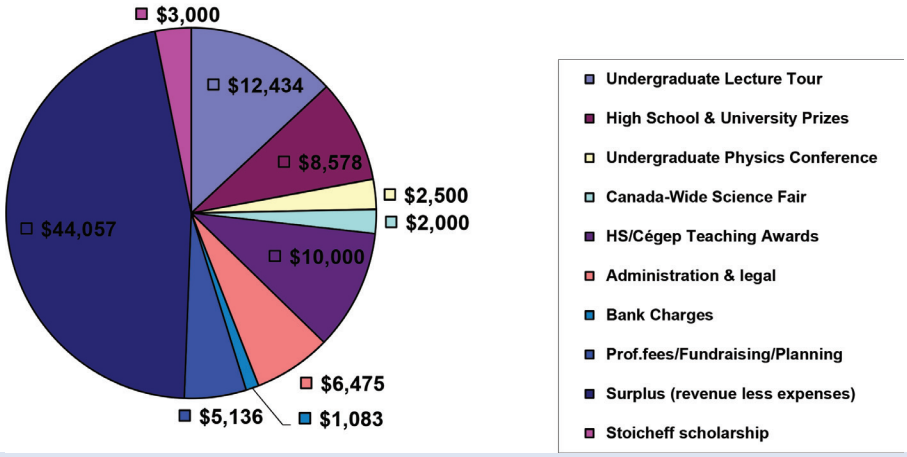

Fig. 2 Expenditures from the CAPF in 2016, based on audited statements

introduction of new CAPF-funded initiatives will be reflected by substantially higher expenses in 2017. Decisions made in 2016 will also result in CAPF reimbursing CAP for future administrative and program delivery work at levels more reflective of realistic costs than might have been the case in the past. Sustaining these activities will require continued development of CAPF's fundraising potential. Some additional information about CAP Foundation finances, including a report from the CAP Secretary/Treasurer, is also included in the CAP Annual Report for Fiscal year 2016.

CAPF STRATEGIC ACTIVITIES IN 2016

The 2015 CAPF Annual Report included an update on strategic activities to July 2016. One exciting development during the first half of 2016 was a generous invitation, from Dr. Alan Carswell, to submit a proposal to the Carswell Family Foundation for matching funding to help support new CAPF initiatives. With Dr. Carswell's help, the CAPF Board developed a proposal to the Carswell Family Foundation (CFF) and, in March 2016, the CAPF and CFF entered into an agreement whereby the CFF would match donations to the CAPF above its normal donation levels for that year (up to $50,000). The CAPF *Ignite the Spark* campaign was announced to potential sponsors and CAP members in May 2016 and the formal launch of the campaign occurred at the 2016 CAP Congress in Ottawa. Donors committing to a specified contribution prior to Congress were recognized as charter donors in the program for the 2016 CAP Recognition Gala held at the Shaw Centre in Ottawa. One of the highlights was a pre-Gala reception, for charter donors and CAP award winners, attended by His Excellency the Right Honourable David Johnston, Governor General of Canada, Dr. Art McDonald, winner of the 2015 Nobel Prize for Physics, and Dr. Alan Carswell of the Carswell Family Foundation. Following the 2016 CAP Congress, the *Ignite the Spark* campaign remained an important focus of CAPF Board attention. As noted below, one aspect of this focus was the pursuit of selected initiatives intended to demonstrate, to existing and anticipated donors, the potential impact of CAPF-funded activity.

The 2016 calendar year was only the third full year of operation for the CAP Foundation and some of the focus was on considering and defining the distribution of responsibilities and resources between CAP and CAPF. In principle, the CAP Foundation is the charitable entity that raises funds for education and outreach activities that are executed by the CAP. Recognizing, however, that successful introduction of new education and outreach initiatives can be a prerequisite to the success of ongoing fundraising efforts, the CAPF Board did, in 2016, begin planning for a small number of projects to educate Canadian secondary school and university students about the impact of physics training on career opportunities. These developments included the development and distribution of posters highlighting non-academic career opportunities for physics graduates, the production of a series of short video profiles of physics graduates working outside of traditional academic environments, and the laying of groundwork for events, at CAP Congress and various student conferences, at which students can interact with prospective non-academic employers. The latter initiative is intended both to give students a better sense of the scope of physics-related career opportunities and to help potential employers better appreciate the valuable resource that exists in the pool of highly trained physics graduates. As outlined below, projects

for which planning was underway in 2016 began to be executed in 2017.

During its third year of existence, the CAP Foundation also examined and refined some of its existing modes of operation. One decision made in 2016 was to expand the CAP's sponsorship of physics prizes at the Canada Wide Science Fair from the senior level to include the intermediate and junior levels. This decision was implemented at the 2017 CWSF in Regina where CAP sponsored prizes at the senior, intermediate and junior levels (see list of recipients in this issue). Another decision made in 2016 was to add a student member to the CAP Foundation Board. This decision was also implemented in 2017.

CONCLUSION AND OUTLOOK

For CAPF, 2016 was a transformative year. Support was provided for a core suite of activities that enrich and reward excellence in the pursuit of an education in physics. These include the University and High School Prize exams, the High School/CEGEP teaching awards, the undergraduate lecture tour, graduate student awards, the Canadian Undergraduate Physics Conference, etc. At the same time, the CAPF, in response to needs identified in the recent CAP Strategic Plan, identified novel initiatives to enrich the experience of an education in physics and promote the value of such an education to students and to Canada and implemented a new and ambitious approach to fundraising to support those initiatives. Both in terms of the development and implementation of new initiatives to enrich physics education and the funding of those initiatives, significant challenges and opportunities remain. The CAPF Board remains committed to addressing those challenges and, with the support of CAP members and donors, realizing those opportunities.

The CAPF Board is deeply and sincerely grateful to the many individual donors and corporate / institutional sponsors who responded to the *Ignite the Spark* campaign in 2016 and we hope that new and existing donors will continue to provide the support needed to help animate the next generation of Canadian physicists. The CAPF Board is particularly grateful for the encouragement, advice and generous support provided by Dr. Alan Carswell and the Carswell Family Foundation as we continue to explore the ways in which this community can make the study of physics a rich and rewarding experience for our students.

CAPF STRATEGIC ACTIVITIES – UPDATE TO JUNE 2017

Given the timing of this report's preparation, the CAPF Board is taking this opportunity to include the following short update on activities to June 2017.

The first half of 2017 saw significant progress in several CAPF efforts.

The Board approved partial travel support for up to 20 students to travel to the August 2017 Canada-America-Mexico Graduate Student Conference in Washington, D.C.

The Board also welcomed its first CAPF Student member, Kyla Smith. Kyla has joined the CAPF Board for a one-year term.

Kyla Smith and Gabor Kunstatter worked with the rest of the Board and CAP's graphic designer to develop a poster for distribution to all Canadian high schools. The poster, with the title "Spot the Physicist", featured a number of physics graduates working in careers not normally identified as traditional physics pursuits. The objective was to communicate, to students and their parents, that training in physics provides valuable training for a much broader range of rewarding careers than they might have imagined. After feedback from a focus group and some refinement of the design, the poster was distributed, in May, to every high school in Canada.

After reviewing responses to a request for proposals, the CAPF Board also engaged a company, *Media One*, to produce a series of five short videos, under the title "Hidden Physicists", also profiling physicists who have used skills developed in the course of their physics training to pursue successful careers beyond what might be thought of as traditional academic physics. The first video, featuring a married couple both trained in physics but working in medical physics and video game production was previewed at the 2017 CAP Congress. It is expected that the roll-out of the whole series of videos will take place in the months following Congress.

The CAPF Board also cooperated with local organizers and the CAP Councillor Representing Graduate Students to present an Employer-Student Meet and Mingle event at the 2017 CAP Congress. Speakers at the event were Dr. Ian D'Souza of COM DEV International, who is also CAP's Director of Industrial Affairs, and Mr. Dan Gale, Vice-President and CTO of CMC Microsystems. This event was well received and similar events are being planned for upcoming undergraduate conferences and CAP Congresses.

Board Members LeeAnn Janissen and Michael Roney agreed to stand for re-election to the Board and were renewed for three-year terms. Richard MacKenzie, CAP Past-President, was invited to remain on the Board as a non-voting member and will be available to chair one or more implementation subcommittees as needs arise. The CAPF Board continues to search for members, particularly from outside the academic environment, who can contribute to the breadth, balance, and skill set of the Board. Full bios of all current CAPF Board members can be found at https://www.ca.ca/capf/directors/.

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TRIUMF, Perimeter Institute, and Association of Professional Engineers and Geoscientists of British Columbia (APEGBC)

Sponsors - 2016 Perimeter Institute Physics Education Scholarship, in partnership with CAP and IPP.

(Recipient was 2016 HS Teaching Award winner Jeff Goldie from Strathcona Secondary School in Edmonton, AB)

Perimeter Institute and Institute for Particle Physics

Sponsors – 2016 Canadian Research Experience Opportunities (for HS Teacher Award winners)

SNOLAB, TRIUMF, Canadian Light Source (CLS), and Perimeter Institute (PI)

We remind our readers that donations to the CAPF *Ignite the Spark* campaign are tax deductible. Contributions may be made by anyone, at any time, via the secure online form at: https://www.cap.ca/donate/, or during the annual membership renewal. Tax receipts will be issued for donations of $10 or more.

FONDATION DE L'ACP - RAPPORT ANNUEL 2016 DU CONSEIL D'ADMINISTRATION[1]

À PROPOS DE LA FONDATION DE L'ACP

La Fondation de l'ACP est un organisme de bienfaisance enregistré[2], administré par un conseil d'administration élu par le Conseil de l'ACP. Les fonds provenant de donateurs et d'entreprises partenaires, plus ceux de campagnes de souscription ciblées, servent à financer les principales activités d'éducation et de sensibilisation menées à l'appui de la physique au Canada.

Conseil d'administration, juin 2016 - juin 2017

(les notices biographiques des membres du conseil d'administration figurent au site Web de la FACP, à http://www.cap.ca/fr/FACP)

J. Michael Roney, phys.
Université de Victoria
(Président)

Michael R. Morrow, phys.
Université Memorial
(vice-président et secrétaire par intérim)

Kyla Smith
Étudiante diplomée
Université du Manitoba

LeeAnn Janissen
Artiste en céramique
Toronto

Sinan Akdeniz
Président,
East Coast Fund Management Inc.,
Toronto

Peter Calamai
expert en communications,
pigiste et rédacteur en chef,
Ottawa

Gabor Kunstatter, phys.
Université de Winnipeg

Le trésorier de la FACP est David Lockwood, phys., du CNRC; la dirigeante est Francine Ford, de l'ACP

RÉSUMÉ

L'année civile 2016 était la troisième de plein fonctionnement de la Fondation de l'ACP (FACP). Ce fut une année d'intense activité au cours de laquelle le Conseil de la Fondation a lancé sa première grande campagne de financement, dirigé la mise en place de ses activités existantes pour améliorer et enrichir l'apprentissage de la physique au Canada et jeté les bases de nouvelles initiatives de formation pour appuyer le plan stratégique de l'ACP. Au cours de 2016, le Conseil de la FACP s'est réuni 19 fois. Deux de ces rencontres (au Congrès d'Ottawa et à la fin de septembre à Toronto) ont réuni en personne de nombreux membres du Conseil, et les autres ont été tenues par téléconférence.

Se fondant sur la planification amorcée en 2015, la FACP a lancé la campagne de financement « Allumer la flamme » juste avant le Congrès 2016 de l'ACP. La portée de cette campagne a sensiblement grandi à la suite de l'assentiment de la fondation de la famille Carswell à égaler les dons reçus par la FACP (jusqu'à 50 000 $) en réponse à cette campagne. Le Conseil de la FACP est très reconnaissant des conseils et de l'appui du Dr Alan Carswell, qui ont rendu la chose possible. Le succès initial de la campagne « Allumer la flamme » a procuré à la FACP les ressources requises pour réaliser de nouvelles initiatives propres à aider les étudiants canadiens à saisir la portée d'une formation en physique et à enrichir l'expérience de cette formation. Dès le début de 2017, on avait déjà amorcé la réalisation de certaines initiatives nouvelles, dont une affiche distribuée dans toutes les

1 La publication du rapport annuel 2016 de la FACP a été reportée du N° 2 au N° 4 du Vol. 73 (2017) de *La Physique au Canada* à cause d'un retard dans la finalisation des états financiers de 2016. Celle du rapport de 2017 est reportée au N° 2 du Vol. 74 (2018) de *La Physique au Canada*.

2 Numéro d'enregistrement d'organisme de bienfaisance : 835627134RR0001.

écoles secondaires du Canada, une série de brèves vidéos montrant des physiciens dans des carrières non académiques et l'organisation de rencontres étudiants-industrie. Le Conseil de la FACP est reconnaissant aux nombreux donateurs qui, en 2016, ont appuyé les activités de formation de la FACP par des dons lors du renouvellement de leur adhésion à l'ACP ou directement en réponse à la campagne « Allumer la flamme ». Il est particulièrement reconnaissant envers le Dr Alan Carswell et la fondation de la famille Carswell pour leur encouragement et leur remarquable aide généreuse en cette année complète, la troisième, de fonctionnement de la FACP. Les activités financées par la FACP ne sont possibles que grâce aux dons importants de temps et d'efforts des membres de l'ACP, de son Conseil et des membres de son personnel, et le Conseil de la FACP est vivement reconnaissant de leur apport. Les activités financées par la FACP inspirent étudiants et enseignants à viser l'excellence dans l'enseignement, l'apprentissage et la découverte de la physique. Ces activités inspirent et encouragent les étudiants tout comme les enseignants à atteindre des objectifs élevés en recherche, enseignement et apprentissage de la physique au Canada. L'objectif ultime de la FACP est de contribuer à la capacité du Canada à relever les défis futurs en inspirant la prochaine génération de physiciens.

ACTIVITÉS DE 2016

La FACP est l'organisme qui surveille les grandes activités d'enseignement et de sensibilisation à la physique conformes au mandat général de l'ACP. Elle finance et administre ces activités, secondée par des collectes de fonds ciblées et une ponction au fonds général de l'ACP. La liste des activités financées par la FACP figure à https://www.cap.ca/fr/facp/. Voici des exemples de ces activités en 2016.

Bourse Stoicheff

Créé en 2012 en mémoire du Dr Boris Stoicheff, ce prix est remis chaque année à un étudiant talentueux d'un cycle supérieur, qui a fait preuve d'excellence en recherche et d'un service important à la collectivité de l'optique ou de la physique. La bourse de 2016, administrée par la Fondation de l'ACP, a été décernée à Christopher Pugh de l'Université de Waterloo pour ses recherches et les progrès technologiques liés à la transmission à longue distance de photons intriqués et des tests fondamentaux de l'intrication de trois photons ainsi que pour son apport aux collectivités de la physique et autres, plus générales.

Tournée de conférenciers pour étudiants en physique

La Tournée nationale de conférenciers pour étudiants en physique est le programme le plus important relevant de la FACP. Les coûts en sont répartis entre les départements de physique participants et l'on recueille des fonds supplémentaires chaque année, en collaboration avec les partenaires de l'industrie et du gouvernement selon le cas, pour les défrayer. La tournée de 2016 comportait des conférences données par 17 conférenciers différents dans 51 départements de physique au Canada (voir en détail à https://www.cap.ca/fr/activites/tournee-de-lacp/programme-tournee-2016/).

PRIX

En 2016, l'ACP a tenu ses examens annuels à la fois aux niveaux secondaire et universitaire. Pour les examens au niveau secondaire, les prix (500 $, 300 $ et 200 $, respectivement) décernés aux trois meilleures notes sur le plan national sont allés à des étudiants, tous ontariens. De plus, la FACP a remis trois prix (250 $, 150 $ et 100 $, respectivement) pour les trois meilleures notes dans chacune des dix provinces. En 2016, l'examen universitaire Lloyd G. Elliot de l'ACP a été coordonné par le Département de physique de l'Université de Waterloo et tenu le 2 février 2016. Soixante-dix-sept étudiants de 14 universités/collèges s'y sont prêtés. En 2016, le lauréat du 1er prix de ce concours a été Simon Axelrod, de l'Université Queen's. Les lauréats des 2e et 3e prix ont été respectivement Chris Ni, Université de Toronto, et Sam Leutheusser, Université de la Colombie-Britannique. Tous les détails pour les prix des niveaux secondaire et universitaire figurent à https://www.cap.ca/fr/activites/medailles-bourses/prix-etudiants/.

Le **Prix d'excellence de l'ACP en enseignement de la physique au secondaire et au collégial** a été créé en 2010. Sa notoriété ne cesse de grandir dans les écoles secondaires et cégeps de tout le Canada. Ce prix est actuellement parrainé au niveau national par l'ACP, TRIUMF, l'Institut Périmètre et l'Institut de physique des particules et, au niveau régional, par l'Association of Professional Engineers and Geoscientists of BC. Il comprend une subvention et une invitation à profiter de l'une des occasions de formation au CERN, SNOLAB, TRIUMF, Centre canadien de rayonnement synchrotron (CLS) ou à l'Institut Périmètre (PI).

Voici les cinq enseignants exceptionnels de l'ensemble du Canada à avoir reçu ce prix en 2016 :

Favian Yee, North Delta Secondary School pour la Colombie-Britannique et le Yukon
Jeff Goldie, Strathcona High School pour les Prairies et les Territoires du Nord-Ouest
Christopher Meyer, York Mills Collegiate Institute pour l'Ontario
Rhys Adams, Vanier College pour le Québec et le Nunavut
Steve Greer, Charles P. Allen High School pour l'Atlantique

Jeff Goldie s'est vu décerner la bourse 2016 de l'Institut Périmètre en enseignement de la physique, comprenant une aide aux déplacements (fournie par l'Institut Périmètre, l'ACP et l'Institut de physique des particules) afin d'assister à un atelier international spécial de trois semaines pour enseignants au secondaire donné par le CERN, premier

laboratoire du monde en physique des particules situé à Genève, et permettant de prendre part au Programme « Einstein Plus » 2017 de l'Institut. Le compte rendu de Jeff Goldie sur l'atelier de 2016 a paru dans *La Physique au Canada, volume* 73, Nº 1 (2017). Steve Greer a en outre eu l'occasion de participer à une expérience de recherche de cinq jours au CLS en décembre 2016.

Soutien de conférences

La 52e Conférence canadienne des étudiants de physique (CCEP) s'est tenue à l'Université Dalhousie en octobre 2016, réunissant plus de 124 étudiants du premier cycle de 29 universités. La FACP a fourni une aide financière aux participants. Outre les exposés étudiants, il y a eu quatre conférences en plénière, prononcées par Andrew Rutenberg, Arthur Carty, Eden Full Goh et Eli Yablonovitch. Un compte rendu de la CCEP 2016 figure dans le présent numéro de *La Physique au Canada.* La FACP a fourni une aide financière aux étudiants qui ont participé à la 53e conférence, tenue à l'Université Carleton en octobre 2017 (un compte rendu en sera donné dans le Nº 2 du Vol. 74 (2018) de *La Physique au Canada*).

La Conférence d'étudiants diplômés de physique Canada-États-Unis-Mexique (CAM) a lieu tous les deux ans, mais il n'y en a pas eu en 2016. La Conférence CAM suivante s'est tenue en 2017, à Washington, D.C. Un compte rendu en sera publié dans le Nº 2 du Vol. 74 (2018) de *La Physique au Canada*.

FINANCES DE LA FACP

L'année civile 2016 en était une de transition pour la FACP. L'un des faits nouveaux épatants concernant la collecte de fonds par la FACP en 2016 est survenu en mars lorsque la fondation de la famille Carswell (CFF) a généreusement accepté d'égaler les dons à la FACP dépassant le niveau normal pour l'année (jusqu'à 50 000 $). Cela a rehaussé sensiblement le profil de la campagne de financement « Allumer la flamme », lancée juste avant le Congrès 2016 de l'ACP. En raison de ces faits nouveaux, les dons à la FACP sont passés à 66 375 $ pour 2016 comparés à14 330 $ pour 2015. Le niveau des dons de 2016 comprend les dons des membres au niveau habituel, ceux des membres en réponse à la campagne « Allumer la flamme » et un don de la Fondation de la famille Carswell égal à ce dernier montant.

Les revenus de placement ont aussi beaucoup augmenté, passant de 323 $ en 2015 à 9 384 $ en 2016. D'autre part, les cotisations des membres corporatifs ont chuté de 4 250 $ en 2015 à 2 750 $ en 2016, et la Conférence CAM n'a procuré aucune recette puisqu'elle n'a lieu que les années impaires. Ces faits ont porté le revenu total, de 37 188 $ en 2015, à 95 263 $ en 2016.

À la suite du Congrès 2016 de l'ACP, il y a eu une forte activité de planification des initiatives visées par la campagne de financement, mais les lourdes dépenses pour ces initiatives n'ont commencé qu'après la fin de l'année civile 2016, d'où le fait que le niveau des dépenses pour 2016 est semblable à celui de 2015. Le niveau des frais administratifs et les autres dépenses sont passés de 10 284 $ en 2015 à 6 475 $ en 2016. Cela témoigne, entre autres, de dépenses faites en 2015 mais pas en 2016 et associées aux préparatifs du lancement de la campagne « Allumer la flamme ». Une autre dépense, faite en 2015 mais pas en 2016, est celle de 8 763 $ associée à la Conférence d'étudiants diplômés CAM 2015. D'autre part, certaines dépenses ont été plus élevées en 2016 qu'en 2015. Le montant des honoraires professionnels est passé de 20 $ en 2015 à 5 136 $ en 2016. L'attribution de la bourse Stoicheff a occasionné une dépense supplémentaire de 3000 $ en 2016, par rapport à 2015 où elle avait été octroyée par l'Optical Society of America. Les dépenses de 1 322 $ pour la Tournée de conférenciers de l'ACP ont été plus élevées en 2016 qu'en 2015. Cela a entraîné une légère baisse des dépenses totales de la FACP, qui sont passées de 53 399 $ en 2015 à 51 206 $ en 2016.

Le résultat net des activités décrites ci-dessus est que les revenus de la FACP pour l'année civile 2016 ont dépassé de 44 057 $ les dépenses pour la même période. On prévoit que

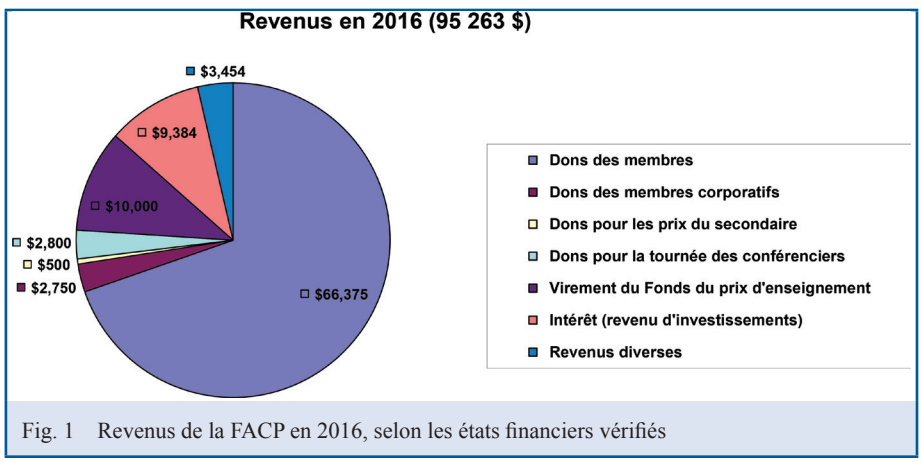

Fig. 1 Revenus de la FACP en 2016, selon les états financiers vérifiés

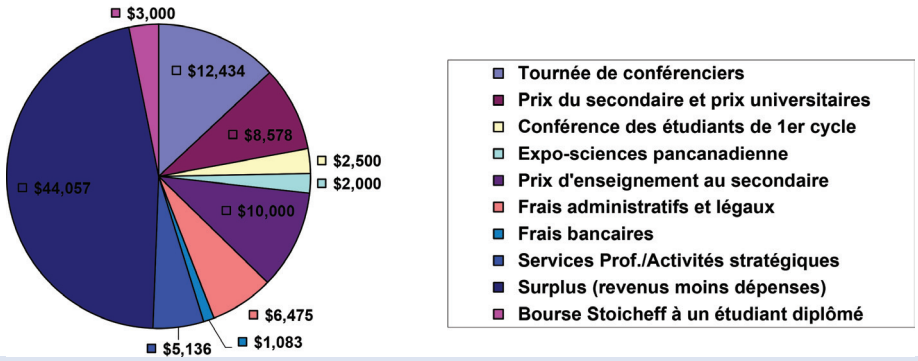

Fig. 2 Dépenses de la FACP en 2016, selon les états financiers vérifiés

l'instauration de nouvelles initiatives financées par la FACP entraînera des dépenses sensiblement plus élevées en 2017. Des décisions prises en 2016 permettront aussi à la FACP de rembourser à l'ACP les futurs frais administratifs et ceux de mise en œuvre des programmes à des niveaux correspondant mieux aux coûts réels que par le passé. Le financement de ces activités obligera à accroître sans cesse le potentiel de levées de fonds de la FACP. Des renseignements supplémentaires sur les finances de la Fondation de l'ACP, dont un compte rendu du secrétaire/trésorier de l'ACP, figurent aussi dans le rapport annuel de l'ACP pour l'exercice financier 2016.

ACTIVITÉS STRATÉGIQUES DE LA FACP EN 2016

Le rapport annuel 2015 de la FACP fait le point sur les activités stratégiques, au mois de juillet 2016. L'un des faits les plus marquants du premier semestre de 2016 a été l'invitation généreuse du Dr Alan Carswell à proposer à la fondation de la famille Carswell d'offrir un financement de contrepartie pour aider les nouvelles initiatives de la FACP. Grâce à l'aide du Dr Carswell, le Conseil de la FACP a soumis une proposition à la fondation de la famille Carswell (CFF) et, en mars 2016, la FACP et la CFF ont conclu une entente qui amène la CFF à égaler les dons à la FACP dépassant le niveau normal pour l'année (jusqu'à 50 000 $). La campagne de la FACP « Allumer la flamme » a été annoncée aux partenaires éventuels et aux membres de l'ACP en mai 2016 et son lancement officiel a eu lieu au Congrès 2016 de l'ACP, à Ottawa. Les donateurs qui s'étaient engagés à donner un montant précis avant le Congrès ont été reconnus à titre de donateurs fondateurs lors du programme du Gala de reconnaissance 2016 de l'ACP au Centre Shaw d'Ottawa. L'un des points marquants a été la réception donnée pour eux et pour les lauréats de prix de l'ACP avant le Gala, où l'on retrouvait Son Excellence le Très Honorable David Johnston, Gouverneur général du Canada, le Dr Art McDonald, lauréat du prix Nobel 2015 de physique, et le Dr Alan Carswell de la fondation de la famille Carswell. À la suite du Congrès 2016 de l'ACP, la campagne « Allumer la flamme » est demeurée un sujet marquant de l'attention du Conseil de la FACP. Tel qu'il est mentionné plus bas, un aspect de ce sujet a été la poursuite d'initiatives choisies visant à montrer aux donateurs actuels et éventuels l'effet que peuvent avoir les activités financées par la FACP.

L'année civile 2016 n'était que la troisième de plein fonctionnement de la Fondation de l'ACP et l'accent visait entre autres à examiner et définir la répartition des responsabilités et des ressources entre l'ACP et la FACP. En principe, la Fondation de l'ACP est l'organisme caritatif qui amasse des fonds pour les activités d'enseignement et de sensibilisation qu'exerce l'ACP. Sachant toutefois que l'introduction fructueuse de nouvelles initiatives sur ce plan peut être essentielle au succès des efforts actuels de collecte de fonds, le Conseil de la FACP a amorcé en 2016 la planification de quelques projets propres à aider les étudiants canadiens des niveaux secondaire et universitaire à saisir la portée de la formation en physique sur les possibilités de carrières. Ces faits nouveaux comprenaient l'élaboration et la distribution d'affiches illustrant des carrières non académiques pour les diplômés en physique, la production d'une série de brèves vidéos montrant les profils de diplômés en physique à l'œuvre hors des milieux académiques traditionnels et la pose des bases d'événements, au Congrès de l'ACP et à diverses conférences d'étudiants auxquelles ceux-ci peuvent interagir auprès d'éventuels employeurs non académiques. Cette dernière initiative vise à la fois à donner aux étudiants un meilleur sens des possibilités de carrière liées à la physique et à aider les employeurs éventuels à mieux cerner les précieuses ressources que comporte le bassin de diplômés en physique hautement qualifiés. Tel qu'il est mentionné plus loin, la réalisation des projets dont la planification était amorcée en 2016 a commencé en 2017.

Pendant sa troisième année d'existence, la Fondation de l'ACP a aussi examiné et amélioré certains de ses modes de fonctionnement en place. Une décision prise en 2016 a été d'étendre le parrainage de prix du niveau supérieur en physique par l'ACP, à l'Expo-sciences pancanadienne, de façon

à inclure les niveaux intermédiaire et junior. Cette décision été mise en œuvre à l'Expo-sciences 2017 de Regina où l'ACP a parrainé des prix aux niveaux sénior, intermédiaire et junior (voir la liste des lauréats dans le présent numéro). Une autre décision prise en 2016 a été d'ajouter un membre étudiant au Conseil de la Fondation de l'ACP. Cette décision a aussi été mise en œuvre en 2017.

CONCLUSION ET PERSPECTIVES

Pour la FACP, l'année 2016 en a été une de transformation. Une aide a été apportée à une série centrale d'activités qui enrichissent et récompensent l'excellence dans l'acquisition d'une formation en physique. Cela comprend les examens aux niveaux universitaire et secondaire, les prix en enseignement au secondaire et dans les cégeps, la tournée de conférenciers pour étudiants en physique, les prix aux étudiants diplômés, la Conférence canadienne des étudiants en physique, etc. Parallèlement, face aux besoins cernés dans le dernier plan stratégique de l'ACP, la FACP a déterminé de nouvelles initiatives pour enrichir l'expérience d'une formation en physique et en promouvoir la valeur pour les étudiants et le Canada et réaliser une approche nouvelle et ambitieuse pour la levée de fonds destinés à ces initiatives. Sur les plans de l'élaboration et de la réalisation des nouvelles initiatives propres à enrichir l'apprentissage de la physique et leur financement, d'importants défis et possibilités demeurent. Le Conseil de la FACP reste engagé à relever ces défis et, avec l'appui des membres de l'ACP et des donateurs, à réaliser ces possibilités.

Le Conseil de la FACP remercie vivement les nombreux donateurs et entreprises/établissements partenaires qui ont répondu à la campagne de financement *Allumer la flamme* en 2016 et nous espérons que les donateurs nouveaux et actuels maintiendront leur appui afin d'aider à inspirer la prochaine génération de physiciens canadiens. Le Conseil de la FACP est particulièrement reconnaissant de l'encouragement, des conseils et du généreux soutien apporté par le Dr Alan Carswell et la fondation de la famille Carswell pendant que nous continuons d'explorer les moyens que la collectivité peut employer pour faire de l'étude de la physique une expérience enrichissante pour nos étudiants.

ACTIVITÉS STRATÉGIQUES DE LA FACP - MISES À JOUR, AU MOIS DE JUIN 2017

Vu le moment où le présent rapport est rédigé, le Conseil de la FACP profite de l'occasion pour ajouter la brève mise à jour suivante, au mois de juin 2017.

Le premier semestre de 2017 montre d'importants progrès dans les efforts de la FACP sur plusieurs plans.

Le Conseil a approuvé une aide partielle au transport d'un maximum de 20 étudiants qui iront, en août 2017, à la Conférence d'étudiants diplômés de physique Canada-États-Unis-Mexique, à Washington, D.C.

Le Conseil a aussi accueilli la première étudiante membre de la FACP, Kyla Smith, entrée au Conseil de la FACP pour un mandat d'un an.

Kyla Smith et Gabor Kunstatter ont travaillé, avec le reste du Conseil et le graphiste de l'ACP à élaborer une affiche à distribuer dans toutes les écoles secondaires du Canada. Cette affiche, intitulée « Trouver le physicien », montre divers diplômés qui exercent des carrières qu'on ne qualifie généralement pas de traditionnelles en physique. L'objectif était de faire savoir aux étudiants et à leurs parents que la formation en physique donne une préparation précieuse à un éventail beaucoup plus vaste de carrières enrichissantes qu'ils auraient pu imaginer. À la suite des commentaires d'un groupe de réflexion et de l'amélioration du modèle, l'affiche a été distribuée en mai dans toutes les écoles secondaires du Canada.

Après avoir examiné les réponses à une demande de propositions, le Conseil de la FACP a aussi retenu les services d'une entreprise, *Media One*, pour produire une série de cinq brèves vidéos intitulées les « physiciens cachés », illustrant le profil de physiciens qui ont employé les talents acquis pendant leur formation en physique à exercer des carrières plus fructueuses que ce qu'on attendrait de la physique académique traditionnelle. La première vidéo, qui montre un couple de gens mariés, tous deux formés en physique mais travaillant en physique médicale et en production de jeux vidéo, a été vue pour la première fois au Congrès 2017 de l'ACP. On prévoit que le lancement de la série complète de vidéos se fera au cours des mois suivant le Congrès.

Le Conseil de la FACP a aussi coopéré avec les organisateurs locaux et le conseiller de l'ACP représentant les étudiants diplômés pour présenter une rencontre employeurs-étudiants au Congrès 2017 de l'ACP. Les conférenciers y ont été le Dr Ian D'Souza de COM DEV International et aussi directeur des Affaires industrielles de l'ACP, et M. Dan Gale, vice-président et CTO à CMC Microsystems. Cet événement a reçu un bon accueil et l'on en prévoit d'autres semblables pour les prochaines conférences d'étudiants du premier cycle et les futurs congrès de l'ACP.

Les membres du Conseil LeeAnn Janissen et Michael Roney ont accepté d'être réélus au Conseil pour un mandat de trois ans. Richard MacKenzie, président sortant de l'ACP, a été invité à demeurer au Conseil à titre de membre sans droit de vote et il lui sera possible de présider un ou plusieurs sous-comités de mise en œuvre, selon les besoins. Le Conseil de la FACP poursuit sa recherche, notamment hors du milieu universitaire, de membres capables de contribuer à accroître l'étendue, l'équilibre et l'ensemble de ses compétences. Les notices biographiques complètes de tous les membres actuels du Conseil de la FACP figurent à https://www.cap.ca/fr/facp/directeurs/.

« MERCI » À NOS DONATEURS ET COMMANDITAIRES EN 2016

Donateurs -

(POUR L'APPUI GÉNÉRAL DE TOUTES LES ACTIVITÉS)

⇨ Les 254 donateurs membres individuels de l'ACP

Adams, Carl
Alcock, A. John
Alexander, Thomas K.
Andrews, H.R.
Archambault, John Paul
Arguin, Jean-Francois
Azuelos, Georges
Bagger, Jonathan A.
Bailey, David
Ball, Gordon
Barrette, Jean
Bayer, Johann
Baylis, William E.
Beairsto, Seamus Thomas Ogilvie
Bechhoefer, John Lawrence
Beda, Johann
Beder, Douglas
Bianucci, Pablo
Bigham, C. Bruce
Blackmore, Ewart Wm
Blomeley, Laura
Boisvert, Jean-Sebastien
Bolton, Richard
Bonnin, Xavier
Bowden, Timothy
Bradley, Brian
Braffman-Miller, Judith
Brewer, Jess
Brooks, Robert
Butler, Malcolm N.
Cachazo, Freddy
Campbell, Melanie C.W.
Carbno, Collin
Carswell, Allan
Chatwin-Davies, Aidan
Clancy, J. Patrick
Code, R. Fraser
Corbett, James
Corns, Robert
Cote, Christian-Yves
Côté, René
Couture, Gilles
Cownden, Brad
Crandles, David
Crawford, Travis
Dahn, Douglas
Dandar, Daniel
Dasgupta, Arundhati
Davies, Walter G.
de Bruyn, John R.
de Takacsy, Nicholas B.
Dean, Ishwar K.
Diamond, Miriam
Dobbs, Matthew Adam
Doiron, Charles
Donohue, John Matthew
Drake, Gordon William Frederic
Drummond, James
Eatock, Brian
Edery, Ariel
Elston, Kenneth
Ewan, George T.
Falkenstein, Bruce
Fedosejevs, Robert
Folinsbee, James T.
Ford, Francine
François, Paul
Frank, Mariana
Freeman, Mark R.
Fujita, Masayuki
Gautrin, Henri-François
Giesbrecht, Brent
Gill, David Russell
Gobeil, Yan
Goldie, Jeff
Green, Ralph E.
Greeniaus, L. Gordon
Grondin, Gregory R.J.
Gurd, David
Hallin, Aksel
Hallman, E.D.
Hara, Elmer
Harvey, Nigel
Hasell, Douglas K.
Hasinoff, Michael
Heinrich, Bretislav
Hobill, David
Holt, Richard
Houston, J. Douglas
Howard, Roger
Huber, Garth
Huschilt, John
Hutter, Jeffrey L.
Igarashi, Ryuichi
Jackson, Kenneth Peter
Jacques, Claude
Jarvis, Jim
Jericho, Manfred H.
Johns, Paul
Johnston, Hamish
Joos, Bela
Julian, Stephen
Kalman, Calvin
Keeler, Richard
Kennett, Malcolm
Kieser, William E.
Kilcullen, Patrick
King, James
Knobel, Robert
Koffas, Thomas
Kolios, Michael
Kotlicki, Andrzej
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Nous rappelons au lecteur que les dons à la campagne de la FACP « Allumer la flamme » sont déductibles à des fins fiscales. Tous peuvent faire un don en tout temps grâce au formulaire sécurisé en direct, à cette adresse (https://www.cap.ca/donate/), ou lors du renouvellement annuel de l'adhésion. Un reçu à des fins fiscales sera émis pour tout don de 10 $ ou plus.

Meet Your 2017-18 Executive

PRESIDENT

Dr. Stephen Pistorius is a Professor of Physics and an Associate Professor of Radiology at the University of Manitoba (UM) and a Senior Scientist at CancerCare Manitoba (CCMB) and the Manitoba Research Institute for Oncology and Hematology (RIOH). His current research interests are in cancer imaging for both early detection and optimized radiation therapy.

He holds B.Sc. (Physics & Geography), Hons. B.Sc. (Radiation Physics), M.Sc. (Medical Physics) and Ph.D. (Physics) degrees as well as a post-graduate diploma in Business Management.. He has experience in the military, in industry, in clinical health care (and as a senior administrator) and in academia. He is a certified Medical Physicist, a licensed Professional Physicist, a senior member of the IEEE, and a fellow of the Canadian Organization of Medical Physics (COMP).

Dr. Pistorius has served as the Treasurer and President of COMP, is the Director of the CAMPEP accredited Medical Physics graduate program at the UM, and Vice Director of the UM Biomedical Engineering Graduate Program. He holds numerous national grants, has over 225 publications and presentations, is currently supervising 10 trainees, and collaborates with and supports many more.

Dr. Stephen Pistorius, P.Phys.
University of Manitoba, CancerCare Manitoba and Manitoba Institute of Cell Biology
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VICE PRESIDENT

Bruce D. Gaulin has been a faculty member at McMaster University since 1988, where he is currently Brockhouse Chair in the Physics of Materials and Director of the Brockhouse Institute for Materials Research.

He received his BSc in Physics from McGill, before going on to McMaster for his PhD, working in neutron scattering studies of quantum materials – worked performed mainly at the Chalk River Laboratories. He has held sabbattical appointments at both Oak Ridge and Brookhaven National Labs in the USA.

Prof. Gaulin served as President of the Canadian Institute for Neutron Scattering (1997-2003) and was elected President of the Neutron Scattering Society of America (2009-13). He served as a member and Chair of NSERC GSC-28, and as NSERC Physics Group Chair (2010-13).

He has served numerous science advisory roles in Canada and abroad, including on the Advisory Committee on TRIUMF (2006-10), as Chair of the Science Advisory Committee of the CLS (2004-08), and as Chair of Commission 10 (Structure and Dynamics of Condensed Matter) of IUPAP (2005-08).

Prof. Bruce Gaulin
McMaster University
bruce.gaulin@gmail.compresident@cap.ca

VICE PRESIDENT ELECT

Shohini Ghose is a Professor of Physics and Computer Science and founding Director of the Centre for Women in Science at Wilfrid Laurier University.

She is a theoretical physicist who examines how the laws of quantum physics can be harnessed to transform computation and communication. She and her co-workers made the first movies of cesium atoms demonstrating a connection between chaos theory and quantum entanglement.

Prof. Ghose is the recipient of several awards including a TED Fellowship in 2014. She is past Chair of the CAP Committee to Encourage Women in Physics and is an Associate Editor of the Canadian Journal of Physics. She is an affiliate of the Perimeter Institute for Theoretical Physics and the Institute for Quantum Computing, and a Fellow of the Balsillie School of International Affairs.

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Francine Ford
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Votre executif pour 2017-18

PRÉSIDENT

Le Dr Stephen Pistorius est professeur de physique et professeur agrégé de radiologie à l'Université du Manitoba (UM) ainsi que scientifique chevronné à Action cancer Manitoba et au Manitoba Research Institute for Oncology and Hematology. Le Dr Pistorius axe actuellement ses recherches sur l'imagerie diagnostique du cancer pour la détection hâtive et la radiothérapie optimisée.

Il détient un B.Sc. (physique et géographie), un baccalauréat spécialisé en science (physique du rayonnement), un M.Sc. (physique médicale) et un doctorat (physique) ainsi qu'un diplôme de troisième cycle en gestion d'entreprise. Il possède de l'expérience dans les domaines militaire, industriel, de soins de santé cliniques (et en tant que cadre supérieur) et dans le milieu universitaire. Il est physicien médical agréé et phys. licencié ainsi que membre senior de l'IEEE et membre de l'Organisation canadienne des physiciens médicaux (OCPM).

Le Dr Pistorius occupera les postes de trésorier et président de l'OCPM et il siégera à nombre de comités d'examen des demandes de subvention. À l'UM, il dirige le programme d'études supérieures CAMPEP des physiciens médicaux agréés et il est vice directeur du Programme d'études supérieures en génie biomédical. Il est titulaire de diverses subventions nationales et auteur de plus de 225 publications et présentations. De plus, il supervise 10 stagiaires et collabore avec plusieurs autres, qu'il soutient également.

Dr Stephen Pistorius, phys
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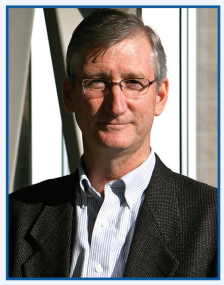

VICE-PRÉSIDENT

Bruce D. Gaulin est membre du corps professoral de l'Université McMaster depuis 1988 et y est actuellement président Brockhouse de la physique des matériaux et directeur du Brockhouse Institute for Materials Research.

Il reçoit un baccalauréat en physique de McGill avant de faire un doctorat à McMaster, travaillant à des études sur la diffusion des neutrons de matériaux quantiques – effectuées principalement aux laboratoires de Chalk River. Le professeur Gaulin détient des nominations en période sabbatique au laboratoire d'Oak Ridge et au Laboratoire national de Brookhaven aux États-Unis.

Le professeur Gaulin est président de l'Institut canadien de la diffusion des neutrons (1997-2003) et est élu président de la Neutron Scattering Society of America (2009-13). Il est membre et président du GSC-28 du CRSNG et président du Groupe de physique du CRSNG (2010-2013).

Il remplit de nombreux rôles consultatifs en science au Canada et à l'étranger, notamment au Comité consultatif de TRIUMF (2006-2010), à la présidence du Comité consultatif sur la science du Centre canadien de rayonnement synchrotron (2004-2008) et à la présidence de la Commission 10 (structure et dynamique de la matière condensée) de l'Union internationale de physique pure et appliquée (2005-2008).

P. Bruce Gaulin
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VICE-PRÉSIDENTE ÉLUE

Shohini Ghose est professeure de physique et d'informatique et directrice fondatrice du Centre for Women in Science à l'Université Wilfrid-Laurier.

En qualité de physicienne théoricienne, elle cherche des moyens d'employer les lois de la physique quantique pour transformer l'informatique et les communications. Avec ses collègues, elle a tourné les premiers films d'atomes de césium, illustrant le lien entre la théorie du chaos et l'intrication quantique.

La professeure Ghose est lauréate de plusieurs prix, dont une bourse TED en 2014, et ancienne présidente du Comité de l'ACP pour encourager les femmes en physique, Elle est aussi rédactrice en chef associée de la Revue canadienne de physique, affiliée à l'Institut Périmètre de physique théorique et à l'Institut d'informatique quantique et boursière de la Balsillie School of International Affairs.

Prr. Shohini Ghose
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Summary of CAP Physics Department Survey – 2016

by Donna Strickland*,
Director of Academic Affairs

This year we had 64% of our member departments participate in the survey. The results of the 2016 Department Survey are summarized in Table 1 and Figs. 1 and 2. Table 1 reports the number of departments responding and the average number of faculty per department. It also reports total numbers of BSc, MSc and PhD graduates, and the total number of physics faculty.

A few changes were made to the survey this year. The first change was to help clarify the number of BSc physics graduates. This year we asked for the number of BSc physics graduates in an Honours or equivalent program and the number of BSc physics graduates in a Majors or equivalent program. The total reported number of graduating BSc physics students was 708, with 472 and 236 receiving an Honours and Majors degree, respectively. This number is well down from the 988 graduates reported last year. This year there were 226 MSc and 142 PhD physics graduates.

Figure 1 shows the number of courses taught, the BSc graduates and grad student enrolment as a function of faculty size. The average number of single-semester courses taught per faculty is 3. The average number of graduate students per faculty is also 3. The number of students in majors program varies widely across the departments.

Summary

The Canadian Association of Physicists (CAP) collects data about the Canadian academic physics community through an annual on-line survey of Canadian physics departments. The information collected in all years is stored in a CAP database that is accessible to all department members [1]. Each year we publish a summary of the annual data in Physics in Canada [2-4]. As part of the survey, information about the departments' graduate programs is updated for CAP's on-line directory of Canadian physics graduate programs found on our web site (www.cap.ca).

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TABLE 1
Summary of Results of CAP Physics Department Survey – 2016.

Number of Departments Reporting	38 (64%)
Total Number of Faculty	693
Average Number of Faculty	18
Smallest Number of Faculty	4
Largest Number of Faculty	61
Total Number of Research Faculty	602 (87%)
Total Number of Female Faculty	109 (16%)
Total Number of New Faculty	37
Total Number of PDFs	341
Total # of BSc Graduates / Year	708
Total # of MSc Graduates / Year	226
Total # of PhD Graduates / Year	143

For the first time, this year's survey asked for numbers of female physics students at all levels as well as female pdf's. In Fig. 2, the female students at each level and female faculty are shown as a function of the faculty size. Over the three years of the survey, the percentage of female faculty members has remained at just 16%. The percentage of graduates that were female was 24, 15 and 23 for an Honours BSc, MSc and PhD degree, respectively. 20% of pdf's in 2016 were women.

I do want to thank all the departments that took the time to fill out the survey and I would like to encourage all the departments to take part in the coming years. I would also like to express my appreciation to the CAP staff who supported development and analysis of the survey.

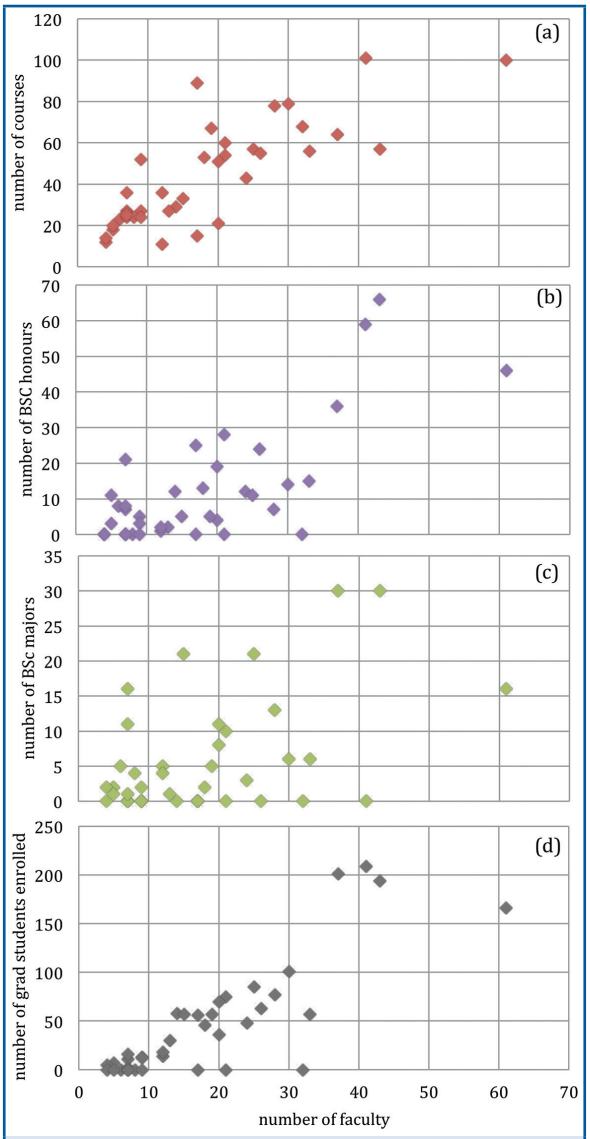

Fig. 1 (a) Number of course sections (one semester courses or equivalent) taught; (b) Number of BSc Honours graduates; (c) Number of BSc Majors graduates; (d) Number of grad students enrolled; each graph given as a function of number of faculty members.

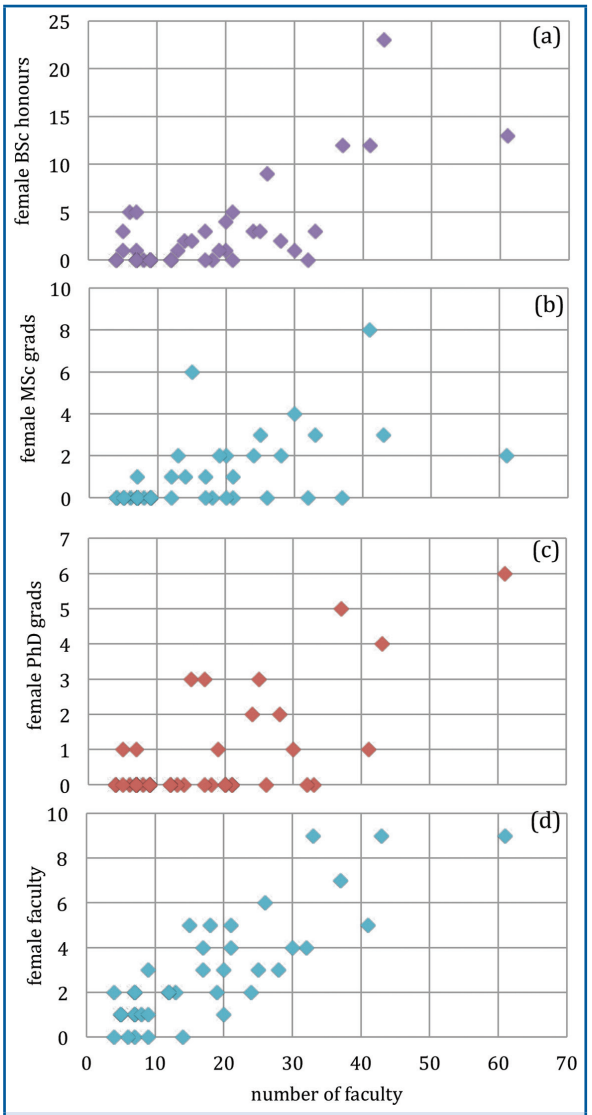

Fig. 2 (a) Number of female Honours BSc grads; (b) Number of female MSc grads; (c) Number of female PhD grads; (d) Number of female faculty; each graph given as a function of number of faculty members.

REFERENCES

1. Departments can access the Survey through the Member Services Login page (https://www.cap.ca/services/) using their department id and password. For help with this, please contact the CAP Office: capmgr@uottawa.ca.
2. B.J. Frisken, *Physics in Canada*, **70**, 198 (2014).
3. B.J. Frisken, *Physics in Canada*, **71**, 214 (2015).
4. D. Strickland, *Physics in Canada*, **72**, 173 (2016).

Science Policy Update
by Aimee Gunther, MSc

Le point sur la politique scientifique
par Aimee Gunther, MSc

There is a lot of cautious optimism on the future of science funding and policy in Canada. On everyone's mind at the Canadian Science Policy Conference 2017 were the results and funding implications for the recent Fundamental Science Review - with many of the authors there to discuss it. This gathering of professionals from industry, academia, and science-based governmental departments saw over 700 delegates discussing the efficacy of science-based knowledge over Canada's last 150 years and the future (http://sciencepolicy.ca/). Physicists were well-represented at this conference with Neil Turok (Perimeter Institute), Nobel Laureate Art McDonald (Queens), and Shohini Ghose (Wilfrid Laurier University) all involved in panels or talks — with Dr. Ghose and me officially representing the CAP.

With the Science Minister Hon. Kirsty Duncan, Chief Science Officer Mona Nemer, and the Governor General Julie Payette all emphasizing a need for increased public science literacy; strengthening Canadian science; and evidence-based decision making, many minds there were led to wonder to what the 2018 federal budget has in store. There were hints of the government's response as the Science Minister announced the creation of a harmonizing council over the three granting councils and Canada Foundation for Innovation (CFI) — the Canada Research Coordinating Committee. In addition, Minister Duncan announced funding for CFI and a plan for improving equity and diversity through limiting the renewals of Canada Research Chair Tier 1 program with firm diversity quotas.

Another one of the key themes of the conference was centred on the development of highly qualified personnel (HQP). With the recent government push for countrywide innovation, HQP across all disciplines for all sectors are in demand. Representatives from government, industry, and beyond are looking to universities, especially graduate supervisors, to train, mentor, and encourage students not only in acquiring technical knowledge but also in necessary "soft skills", such as communication skills and conflict management.

The final message to scientists was to "Tell your stories of the impact of science funding on your research and why it is important (before the federal budget is written)." With any hope, the federal budget 2018 will signal a relief for science in Canada, but we shall see.

L'avenir du financement et de la politique des sciences au Canada suscite beaucoup d'optimisme prudent. À la Conférence canadienne sur la politique scientifique 2017, tous avaient à l'esprit les résultats et les incidences du récent Examen des sciences fondamentales en matière de financement - bien des auteurs étant là pour en discuter. Cette rencontre de professionnels de l'industrie, du milieu universitaire et des ministères à vocation scientifique a réuni plus de 700 délégués pour examiner l'efficacité des connaissances scientifiques pour les 150 dernières années du Canada et pour l'avenir (http://sciencepolicy.ca/). Les physiciens y étaient bien représentés par Neil Turok (Institut Périmètre), le lauréat du prix Nobel Art McDonald (Queens) et Shohini Ghose (Université Wilfrid-Laurier) qui ont tous pris part à des groupes d'experts ou à des conférences - le Dr Ghose et moi-même représentant officiellement l'ACP.

Le ministre des Sciences, l'hon. Kirsty Duncan, l'agente scientifique en chef Mona Nemer et la gouverneure générale Julie Payette ont tous fait valoir la nécessité d'accroître les connaissances des gens en sciences, de renforcer les sciences au Canada et la prise de décisions fondées sur des données probantes, et beaucoup y ont été amenés à se demander ce que nous réserve le budget fédéral 2018. Il y avait des indices de la réponse du gouvernement dans l'annonce, par le ministre des Sciences, de la création d'un conseil chargé d'harmoniser l'action des trois conseils subventionnaires et de la Fondation canadienne pour l'innovation (FCI) - le Comité de coordination de la recherche au Canada. De plus, le ministre Duncan a annoncé le financement de la FCI et un plan d'amélioration de l'équité et de la diversité en limitant les renouvellements du programme de niveau I des chaires de recherche du Canada par des contingents stricts de diversité.

Un autre des thèmes clés de la conférence gravitait autour de la formation de personnel hautement qualifié (PHQ). Le gouvernement militant dernièrement pour l'innovation à l'échelle nationale, le PHQ est recherché dans toutes les disciplines et tous les secteurs. Les représentants du gouvernement, de l'industrie et d'autres milieux se tournent vers les universités, notamment les superviseurs diplômés, afin de former les étudiants, de jouer un rôle de mentor auprès d'eux et de les encourager à ne pas se contenter d'acquérir des connaissances techniques mais aussi les « compétences générales » nécessaires, notamment en communication et en gestion de conflits.

Le message final aux scientifiques a été : « Racontez votre expérience de l'impact du financement des sciences et de son importance pour vos recherches (avant que le budget fédéral ne soit finalisé) ». Nous entretenons quelque espoir que le budget fédéral 2018 sera un allègement pour les sciences au Canada, mais cela reste à voir.

If you are a CAP member, are interested in science policy, and are prepared to be active, we want to hear from you! Please e-mail Kris Poduska at kris@mun.ca.

Since the preparation of this update in mid-November, the 2018 Federal Budget has been released. See https://www.cap.ca/publications/cap-news/2018-federal-budget/ for more information. Ed.

Si vous êtes un membre de l'ACP intéressé par la politique scientifique et que vous êtes prêt à participer activement, communiquez avec Kris Poduska à l'adresse kris@mun.ca.

Depuis la préparation de cette colonne en mi-novembre, le budget fédéral 2018 a été publié. Pour plus d'information voir https://www.cap.ca/fr/publications-fr/nouvelles/le-budget-federal-2018/. Ed.

Book Review Policy

Books may be requested from the Book Review Editor, Richard Marchand, by using the online book request form at http://www.cap.ca. You must be a residing in Canada to request a book.

CAP members are given the first opportunity to request books. For non-members, only those residing in Canada may request a book. Requests from non-members will only be considered one month after the distribution date of the issue of *Physics in Canada* in which the book was published as being available.

The Book Review Editor reserves the right to limit the number of books provided to reviewers each year. He also reserves the right to modify any submitted review for style and clarity. When rewording is required, the Book Review Editor will endeavour to preserve the intended meaning and, in so doing, may find it necessary to consult the reviewer. Reviewers submit a 300-500 word review for publication in PiC and posting on the website; however, they can choose to submit a longer review for the website together with the shorter one for PiC.

La Politique Pour la Critique De Livres

Si vous voulez faire l'évaluation critique d'un ouvrage, veuillez entrer en contact avec le responsable de la critique de livres, Richard Marchand, en utilisant le formulaire de demande électronique à http://www.cap.ca.

Les membres de l'ACP auront priorité pour les demandes de livres. Ceux qui ne sont pas membres et qui résident au Canada peuvent faire une demande de livres. Les demandes des non-membres ne seront examinées qu'un mois après la date de distribution du numéro de la Physique au Canada dans lequel le livre aura été déclaré disponible.

Le Directeur de la critique de livres se réserve le droit de limiter le nombre de livres confiés chaque année aux examinateurs. Il se réserve, en outre, le droit de modifier toute critique présentée afin d'en améliorer le style et la clarté. S'il lui faut reformuler une critique, il s'efforcera de conserver le sens voulu par l'auteur de la critique et, à cette fin, il pourra juger nécessaire de le consulter. Les critiques pour publication dans la PaC doivent être de 300 à 500 mots. Ces critiques seront aussi affichées sur le web; s'ils le désirent les examinateurs peuvent soumettre une plus longue version pour le web.

Books Received / *Livres Reçus*

The following titles are a sampling of books that have recently been received for review. Readers are invited to write reviews, in English or French, of books of interest to them. Unless otherwise indicated, all prices are in Canadian dollars.

Lists of all books available for review, books out for review and book reviews published since 2011 are available on-line at www.cap.ca (Publications).

In addition to books listed here, readers are invited to consider writing reviews of recent publications, or comparative reviews on books in topics of interest to the physics community. This could include for example, books used for teaching and learning physics, or technical references aimed at professional researchers.

Les titres suivants sont une sélection des livres reçus récemment aux fins de critique. Nous invitons nos lecteurs à nous soumettre une critique en anglais ou en français, sur les sujets de leur choix. Sauf indication contraire, tous les prix sont en dollars canadiens.

Les listes de tous les livres disponibles pour critique, ceux en voie de révision, ainsi que des critiques publiées depuis 2011 sont disponibles sur : www.cap.ca (Publications).

En plus des titres mentionnés ci-dessous, les lecteurs sont invités à soumettre des revues sur des ouvrages récents, ou des revues thématiques comparées sur des sujets particuliers. Celles-ci pourraient par exemple porter sur des ouvrages de nature pédagogique, ou des textes de référence destinés à des professionnels.

GENERAL LEVEL

Building Physics From physical principles to international standards (V), Pinteric, Marko, Springer, 2017; pp. 254; ISBN: 978-3-319-57483-7; Price: 113.63.

The Formative Years of Relativity The History and Meaning of Einstein's Princeton Lectures (V), Hanoch Gutfreund & Jürgen Renn , Princeton University Press, 2017; pp. 432; ISBN: 9781400888689; Price: 4537.

The White Confocal (V), Rolf Theodor Borlinghaus, Springer, 2017; pp. 115; ISBN: 978-3-319-55561-4; Price: 101.00.

Theoretical Atomic Physics (V), Harald Friedrich, Springer, 2017; pp. 642; ISBN: 978-3-319-47767-1; Price: 150.26.

UNDERGRADUATE LEVEL

Radiation and Detectors (V), Lucio Cerrito, Springer, 2017; pp. 210; ISBN: 978-3-319-53179-3; Price: 90.20.

The Little Book of Black Holes (V), Steven S. Gubser & Frans Pretorius, Princeton University Press, 2017; pp. 200; ISBN: 9780691163727; Price: 24.95

SENIOR LEVEL

Quantum Photonics (V), Thomas P. Pearsall, Springer, 2017; pp. 292; ISBN: 978-3-319-55142-5; Price: 115.98.

Book Reviews / *Critiques de livres*

Book reviews for the following books have been received and posted to the *Physics in Canada* section of the CAP's website: http://www.cap.ca.

Des revues critiques ont été reçues pour les livres suivants et ont été affichées dans la section "La Physique au Canada" de la page web de l'ACP:http://www.cap.ca.

Communicating Science – A Practical Guide for Engineers and Physical Scientists, by Raymond Boxman and Edith Boxman, World Scientific, 2016, pp. 288, ISBN: 9813144238, price 44.17.

When I saw this title in the list of books to be reviewed for *Physics in Canada*, I was immediately interested. In the 2017 winter semester, I taught a new core course for physics majors at the University of Guelph that focuses on communicating science to non-technical audiences. The title and brief description of the book suggested that some elements could be useful as required reading for future offerings of the course. Having now read the book, it is clear that my students are not the intended audience. What is not clear, however, is who the intended audience actually is.

In my opinion, the single most important rule of communication — in any forum, about any subject — is know your audience. Everything follows from this starting point, from the content, to the duration, the modality, the tone, the detail, the analogies, the examples, the illustrations, etc. Before even reading the book itself, the description on the back suggests that different chapters were written for very different audiences: the 67-page long chapter on writing research reports (journal articles, theses) is intended for graduate students, whereas the comparably shorter chapters on business plans (14 pages) and patents (18 pages) are intended for researchers further along in their careers who are interested in commercializing their results. The last chapter on "Writing Well" is the longest piece of the entire book: 80 detailed pages of guidance that include a table of word-processor features (such as spell-check and automatic numbering of references and figures) and almost 19 pages explaining verbs, verb tenses, verb voice, including five tables defining verbs commonly used in the physical sciences. Three pages alone in this final chapter are devoted to the use of "a, an, and the". This chapter could really only be targeted to readers for whom English is a second language.

The shortest chapter, at 10 pages, is "Reports in the Popular Media". This is what I was expecting to be the main focus of the book based on its title. Their brief discussion is prefaced by saying that communicating with a wider audience can be useful for encouraging the support of taxpayers for continued government funding or for recruiting students to our disciplines. This has always struck me as a rather narrow view of the value of science communication. Early in this chapter the authors note:

"The organization of the various genres for communicating with the general public mentioned in section 8.2 are very different, and detailed guidance is beyond the scope of this book. ... The most important suggestion for preparing any popular publication is to read many examples from the target publication and to note the acceptable content and style."

Since a detailed discussion of the various genres for communicating with the general public is exactly what I was looking for, I will not be using this book in my course.

The main question then – does this book meet the needs of any of the possible aforementioned target audiences? Unfortunately, I don't believe that it does.

Graduate students at the beginning of their studies? The chapter on writing research reports reads as though the authors are assuming that their audience has never read a journal article. Statements such as "The Procedure section describes the sequence of steps taken to obtain the results." and "The Results section presents the results." are just two examples of instances in which the authors could have made assumptions about what their audience already knows. The following chapter on the article submission and review process could be helpful to a first-time author, but the advice found here is the same as would be delivered by the research supervisor or supervisory committee. I just don't see a busy first-year graduate student reading through 67 pages to find useful advice amid the more obvious statements like "Connective words commonly used include: although, however, despite, though, but."

Researchers exploring commercialization? Again, there is useful information in the two chapters related to business plans and patents, but there is also a lot of detail that is likely unnecessary. Anyone considering this route will surely do their homework by reading related patents, so a table on patent jargon (that defines words such as 'aspects' and 'embodiment') seems excessive. Most researchers would likely do better to start exploring business plans and patents by searching online or consulting with the IP and commercialization support staff at their institution.

Perhaps the book is best suited to a graduate student beginning his/her career with English as a second language. It is a detailed discussion of writing and presenting science to colleagues and peers, addressing the minutia of grammar and style in technical communications for those unfamiliar with the language.

For those, like me, interested in a great read on communicating science to non-technical audiences, I highly recommend Alan Alda's recent book: "*If I Understood You, Would I Have This Look on My Face? My Adventures in the Art and Science of Relating and Communicating*". I will definitely use excerpts from Alda's lighthearted and insightful memoir in discussions with my students in Science Communication at the University of Guelph next winter.

Joanne O'Meara, Guelph University

Modern Particle Physics, by Mark Thomson, Cambridge University Press, 2013, pp. 554, ISBN: 978-1-107-03426-6, price 97.95.

Modern Particle Physics, by Mark Thomson, is the perfect resource for those with a general physics background but unfamiliar with the specifics of particle physics. This pedagogical text provides a contemporary, impressively comprehensive study of the subject that can be undertaken over a (relatively) short amount of time. While it is not the ideal text for anyone looking to delve into the intricacies of particle physics in the context of quantum field theory, this works in favour of the target audience; those beginning, or early in, their study of particle physics.

As with its exceptional content, the formatting of Modern Particle Physics is remarkably well thought out; it could serve as a template for future textbooks. The reader can easily focus on the material, by virtue of the large font, clear figures, concise chapter summaries, and completely intuitive layout. *Modern Particle Physics* makes it easy for the reader to focus on the material by using large font, clear figures, concise chapter summaries, and an extremely intuitive layout. Furthermore, explicit definition of all terms and notation at their first instance allows the text to be studied in a self-contained manner, and prevents the intimidating feel of some well-established particle physics textbooks.

Rather than expecting physical intuition to blossom from meticulous mathematical derivations, Thomson frequently mentions experimental results to supplement theory with research

elucidating the physical significance of the topic. Further distancing itself from alternative texts, which often utilize a chronological approach to present material, the history of particle physics is almost entirely absent. This was a calculated decision; one that saves a great deal of time and memory for readers that simply desire a current, working knowledge of the field.

The only prerequisite is a basic background knowledge of quantum mechanics and special relativity, making it easily accessible to graduate students and most upper year undergraduate students. Thomson relies heavily on the Dirac equation to formulate content, avoiding quantum field theory until it must inevitably be introduced in the final chapters, to facilitate discussion of the Higgs mechanics. The inclusion of Higgs physics allows for a more complete picture of the standard model to be presented, and substantiates the eponymous distinction that this text covers modern particle physics. Concluding with a discussion of supersymmetry piques interest in more advanced topics, cleverly coaxing the reader to continue their studies.

Modern Particle Physics marvellously conveys a broad understanding of the core topics in particle physics. I could not recommend this textbook more highly for students learning particle physics, and I believe that even seasoned researchers can benefit from its clear, concise nature. A final word of caution for students using this text; you may find yourself influenced to continue studying particle physics far beyond an introductory course.

Adam Dvorak, Graduate Student
Department of Physics and Astronomy, University of British Columbia

Quantum Information, Computation and Communication, by Jonathan A. Jones and Dieter Jaksch, Cambridge University Press, 2012, pp. 200, ISBN: 9781107014466, price 49.97.

Many people believe that quantum computers are the future of technology because they will allow us to do tasks considerably faster than what we can do with classical computers. The textbook *Quantum Information, Computation and Communication* by Jones and Jaksch, both professors at Oxford University, is a great introduction for undergraduate physics students who are interested in participating in the advent of this very interesting research area. It is a quick read that gives a good view of what can be done with just a few qubits and how.

The book is divided into three parts, the first of which is meant as an exposition to the basic concepts of quantum information needed to understand the other two, that are almost independent of each other, and each part contains many small chapters. Part I introduces the concept of qubits and quantum circuits and explains how to produce single qubits and gates using atoms and photons. Part II describes how to make a quantum computer experimentally and shows many examples of algorithms that can be used on these machines. Part III discusses how to transmit information using quantum mechanics and describes the Bell inequalities and basics of quantum cryptography. Finally, an appendix at the end of the book reviews the notions of quantum mechanics important to understand the content of the book, which are actually very basic. I don't think it is possible to learn the subject from there, but it is a clear review for student who are not totally familiar with it.

Each chapter of the book covers a topic very briefly without going into much detail. The explanations are not always totally clear when they have to do with calculations but the numerous exercises at the end of the chapters (with solutions provided online) help with that. Additionally, the authors often focus on examples instead of proving their statements. Fortunately, there is a short list of good references at the end of each chapter which directs an interested reader in the right direction to learn more about the topic covered.

Apart from a few instances, every topic introduced is discussed from the theoretical and the experimental points of view. I believe the experimental parts are a little more advanced than what is covered in the appendix, but even as a theorist I enjoyed being exposed to how the simple concepts are not that simple in real life. Furthermore, I found that the fact that the discussions are short keeps them accessible enough.

To summarize, this textbook gives a brief introduction to many independent topics in the field of quantum information in a clear way and it discusses the theoretical aspects as well as the experimental ones in a natural manner. I would recommend this book to any physicist, especially to a student, who has at least a basic knowledge of quantum mechanics and wants an answer to the general question *What is quantum information?* However the book is definitely not one that teaches the specifics of a given topic and it does no aim for that either.

Yan Gobeil, McGill University

Science and Human Experience: Values, Culture, and the Mind, by Leon Cooper, Cambridge University Press, 2014, pp. 246, ISBN: 9781107043176, price 16.07.

Merging a myriad of areas, Leon Cooper, 1972 Nobel Laureate in Physics, invites his readers to consider science from many different perspectives. In this collection of talks and essays, Cooper connects science to a range of areas common to human experience, such as faith, art, and prolific works including Dante's Inferno. Throughout this book, the reader's gaze remains on science, but the lenses through which science is viewed continue to change. As Cooper orients, and reorients, his readers he calls them to ask more questions than those that are answered.

Throughout the three areas of discussion within *Science and Human Experience* the reader is drawn to view science from new perspectives, bringing new questions. For this reviewer, two questions rang loudest "can humanity explain the world with science?" and "can science explain humanity?" Cooper provides many discussions in response to these questions, for example, he explores whether our universe is truly Euclidean in nature through the simple explanation of a triangle. Yet, the universe cannot all be explained with science; for example, Cooper discusses how we are always left with the difficult problems, the "easy" problems having been solved. Perhaps it is not that we have solved the easy problems, but that the means needed for the solution have arrived, according to Cooper. So, while we cannot explain the universe in its entirety, the questions we have today may be answered in the future, leaving us with new difficult problems. One is left wondering how much of the universe we can explain with science.

While the limits of science are indeed important, the other question presented by Cooper is "can science explain humanity?" This question was significantly more complex for this reviewer. Through essays about whether we will ever be able to explain consciousness, or achieve it in robots, neural networks, and memory, Cooper explores what it means to be human from a scientific perspective. Admittedly, the essay on Memories and Memory is a bit of a cognitive leap for someone with limited studies in biology; luckily, the other chapters focused on consciousness and memory still provide depth to the exploration of a scientific explanation of humanity. To Cooper, any human experience *can* be explained by science, but this explanation should not replace the experience. In this respect, I would completely agree; while science may one day be able to explain humanity, it is not the only way humanity should be understood.

This book provides a though provoking read for anyone with an interest in science. Cooper does a good job of providing simple explanations from all areas, including literature, art, and science, but having a background in any or each of these areas will certainly help the reader ask deeper questions. As one of the "intrepid few who [began] with the first and read through to the last" (p. xii) essay of this book, I can only say that no apologies were needed Dr. Cooper, I enjoyed my entire experience.

Ellen Watson
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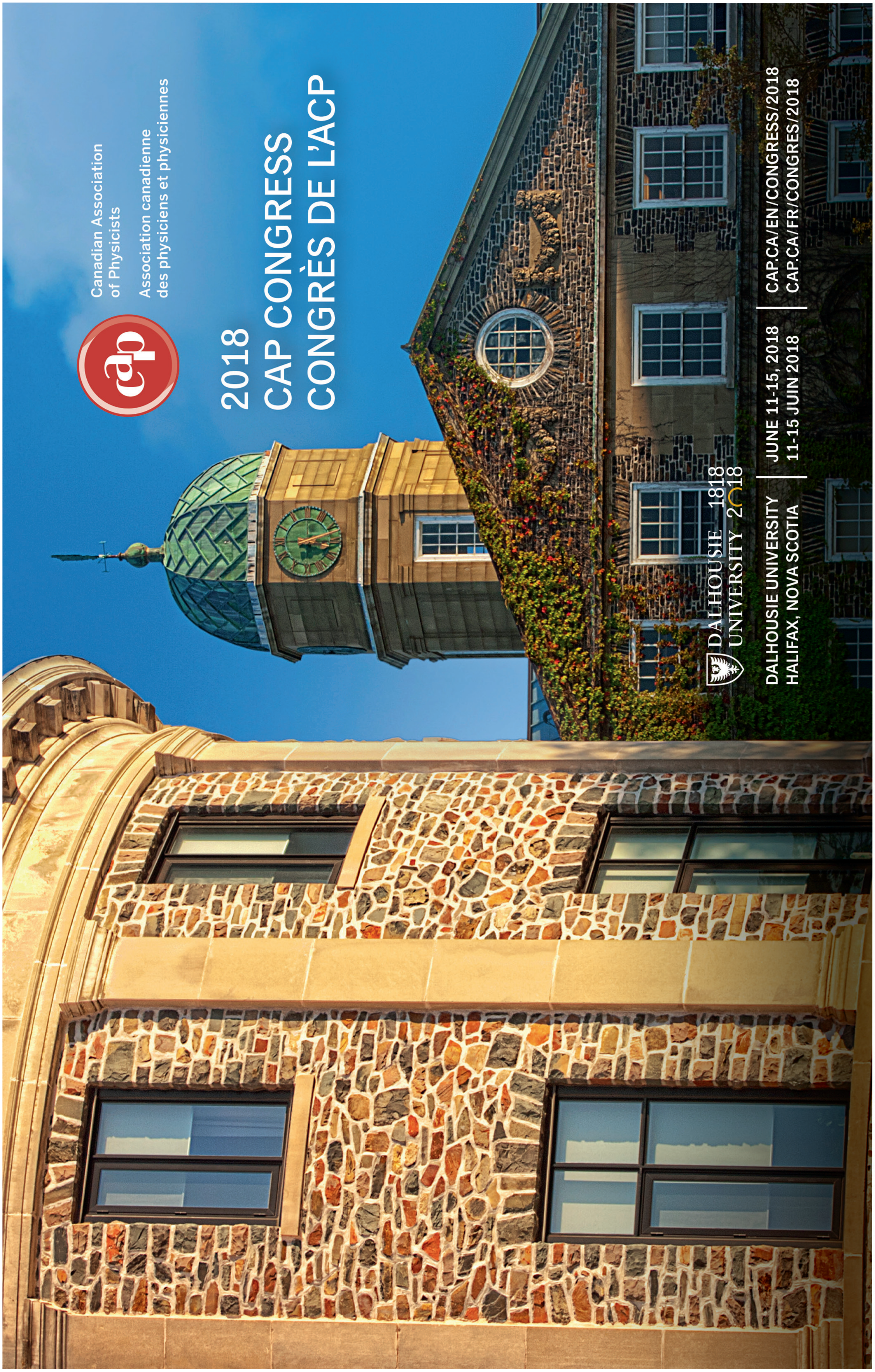

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